



Muon Trigger Upgrade at PHENIX

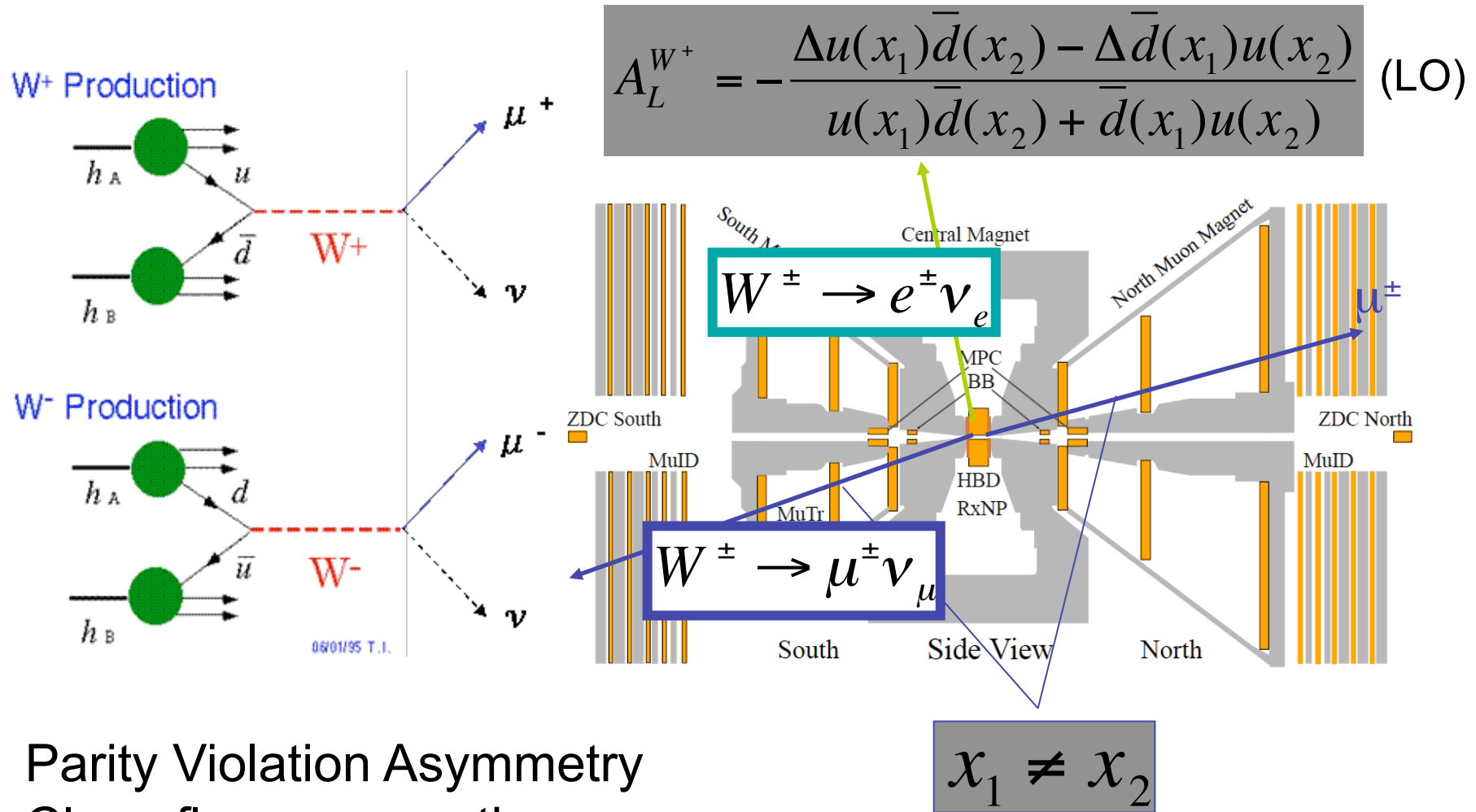
RIKEN/RBRC
Itaru Nakagawa

Summary

- Polarized sea quark measurement via W is very Sexy program for RHIC Spin and should take maximum advantage of it
- However existing PHENIX Muon Arms Cannot Handle High Rates at $\sqrt{s}=500$ GeV
- Need Trigger Upgrade!
- New Triggers have been developed and are under commissioning now

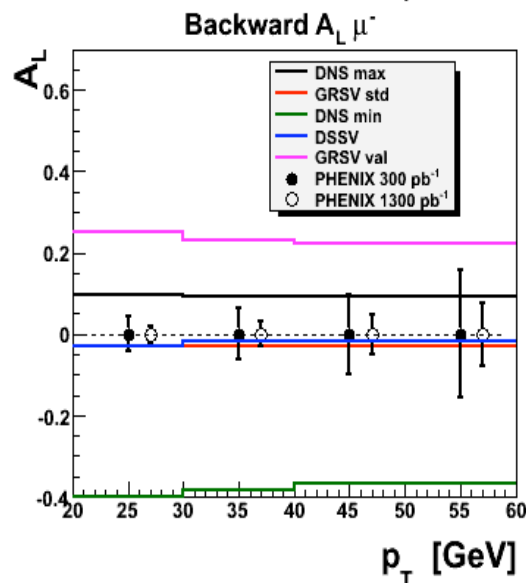
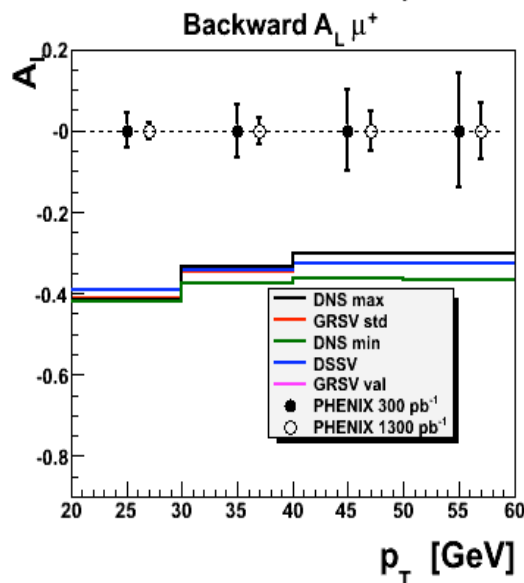
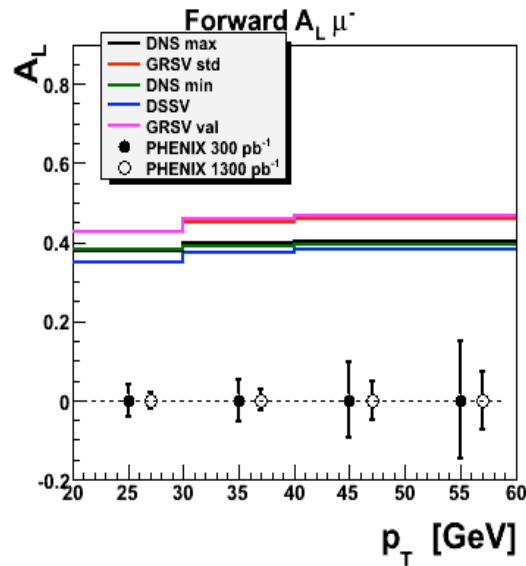
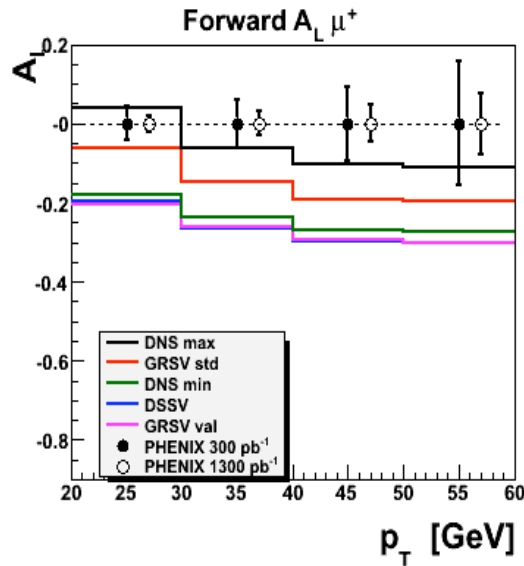
We are getting very close to be ready for W production Run!!

$\sqrt{s}=500 \text{ GeV @ RHIC}$



Parity Violation Asymmetry
Clean flavor separation
w/o fragmentation uncertainty

Projected Sensitivity @ PHENIX



- Full Detector Simulation
- S/B $\sim 3/1$ Assumed
- 300 pb^{-1} and 1300 pb^{-1}

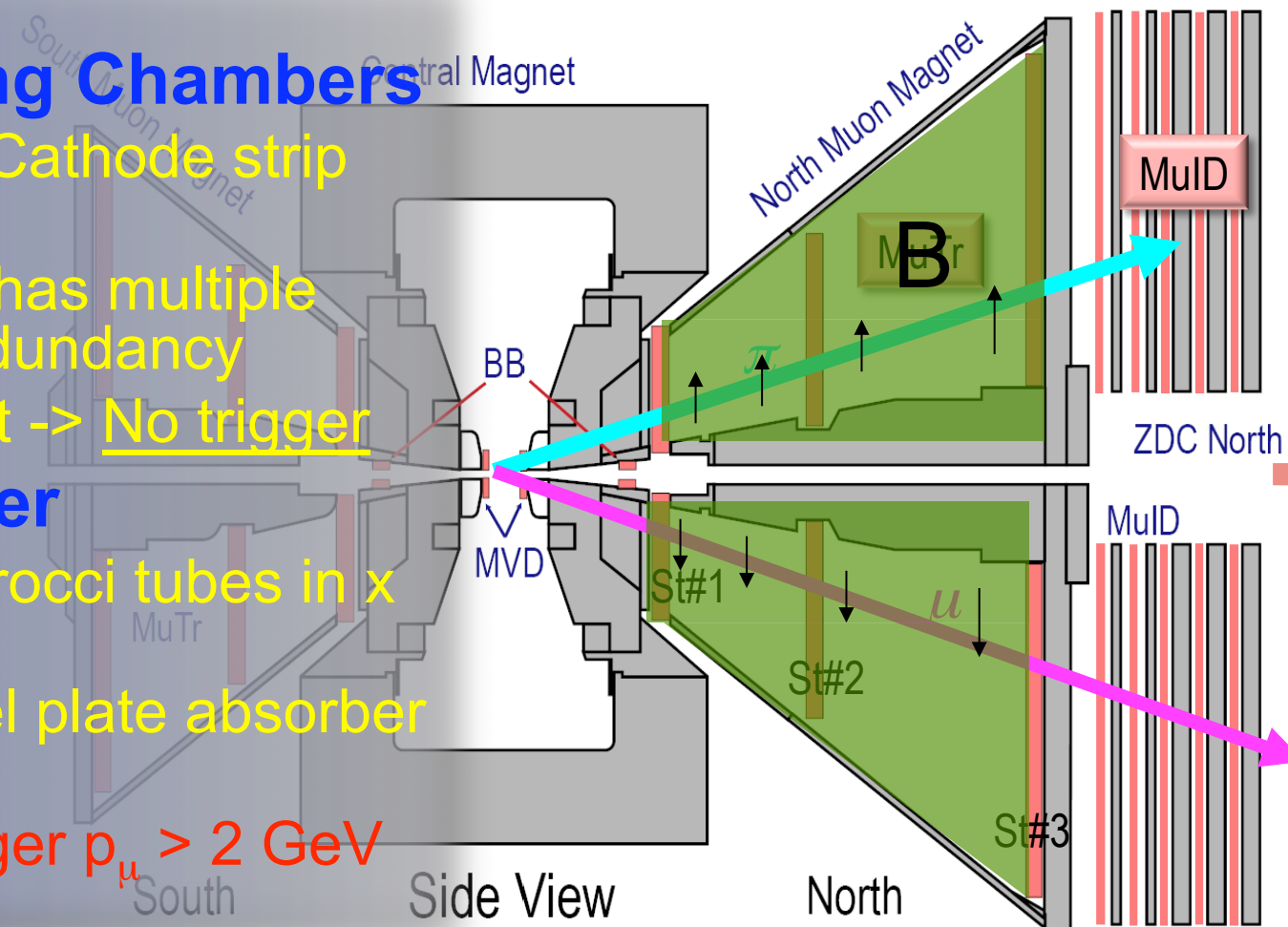
Current Muon System

1. Muon Tracking Chambers

- 3 stations of Cathode strip chambers
- Each station has multiple planes for redundancy
- Slow read out -> No trigger

2. Muon Identifier

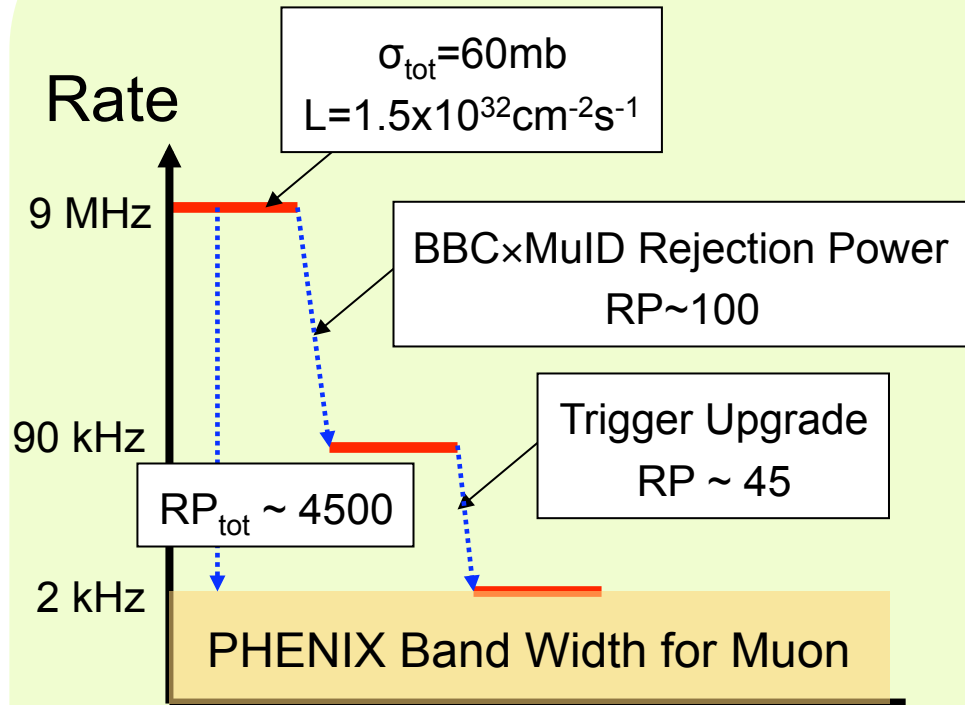
- 5 layers of larocci tubes in x and y
- 80 cm of steel plate absorber (total)
- Provides trigger $p_{\mu} > 2 \text{ GeV}$



Same configuration in South

High Momentum Muon Trigger

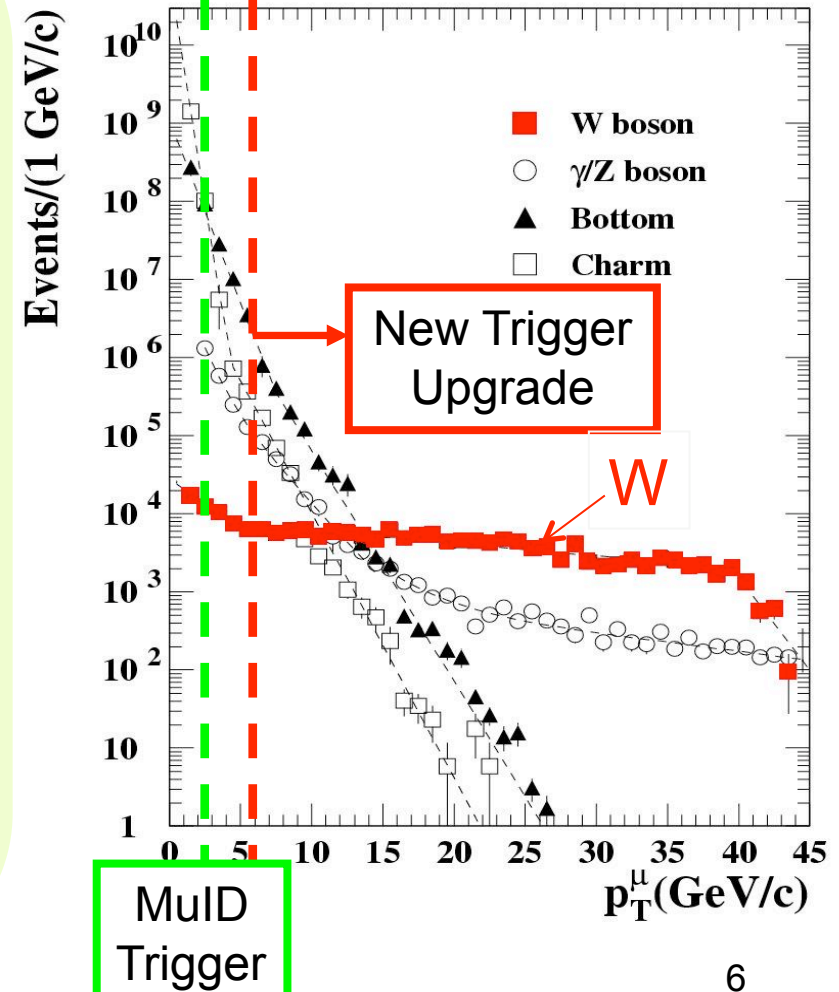
Run11 500 GeV Projection



Required Rejection Power

1. High Rejection Power
2. High Efficiency

Inclusive μ Production, 500 GeV/c



PHENIX Muon Trigger Upgrade

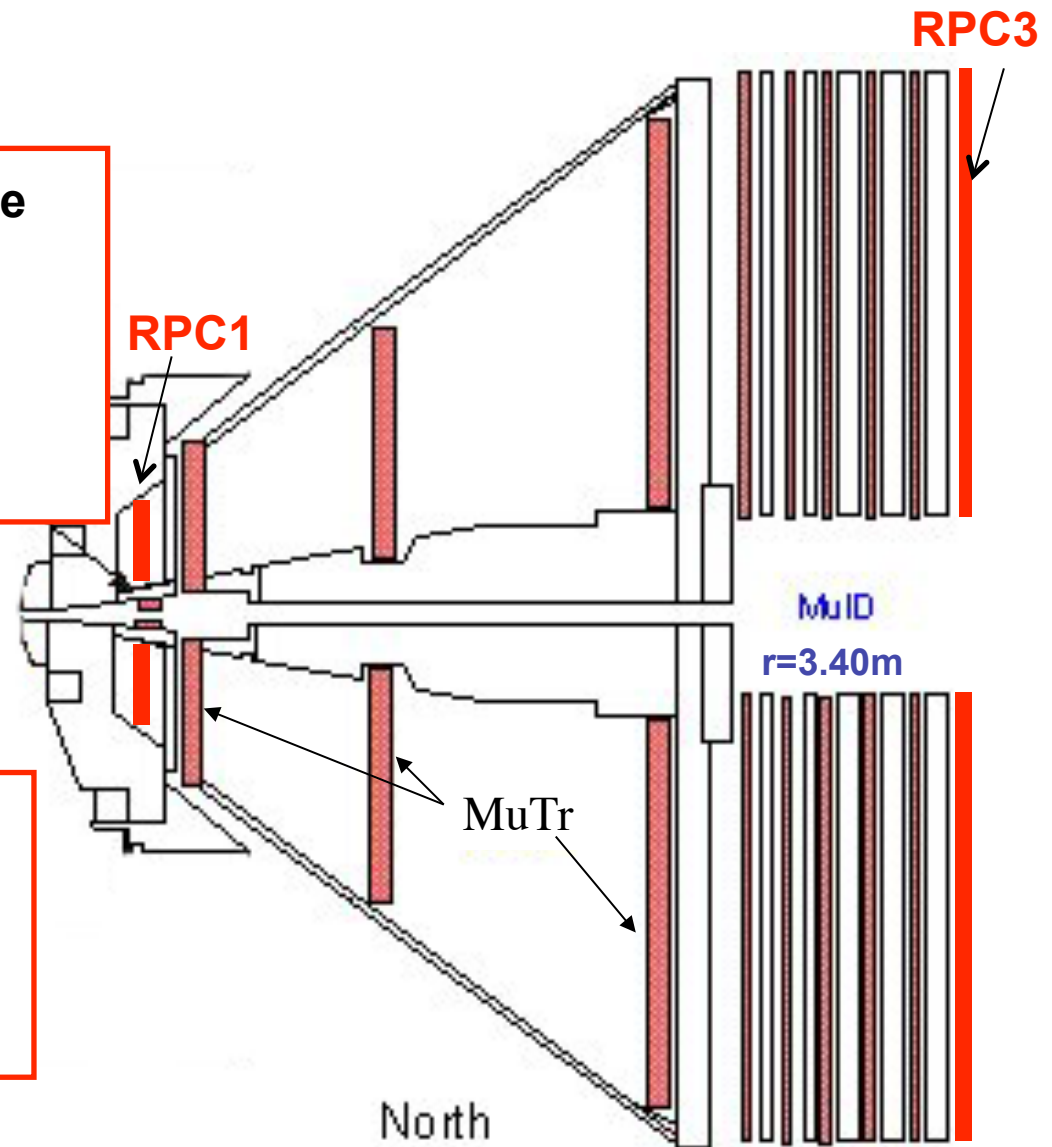
- (I) 2 dedicated trigger Resistive Plate Chambers (**RPC**) stations (CMS design):

~ 1 degree pitch in φ

NSF (Funded)

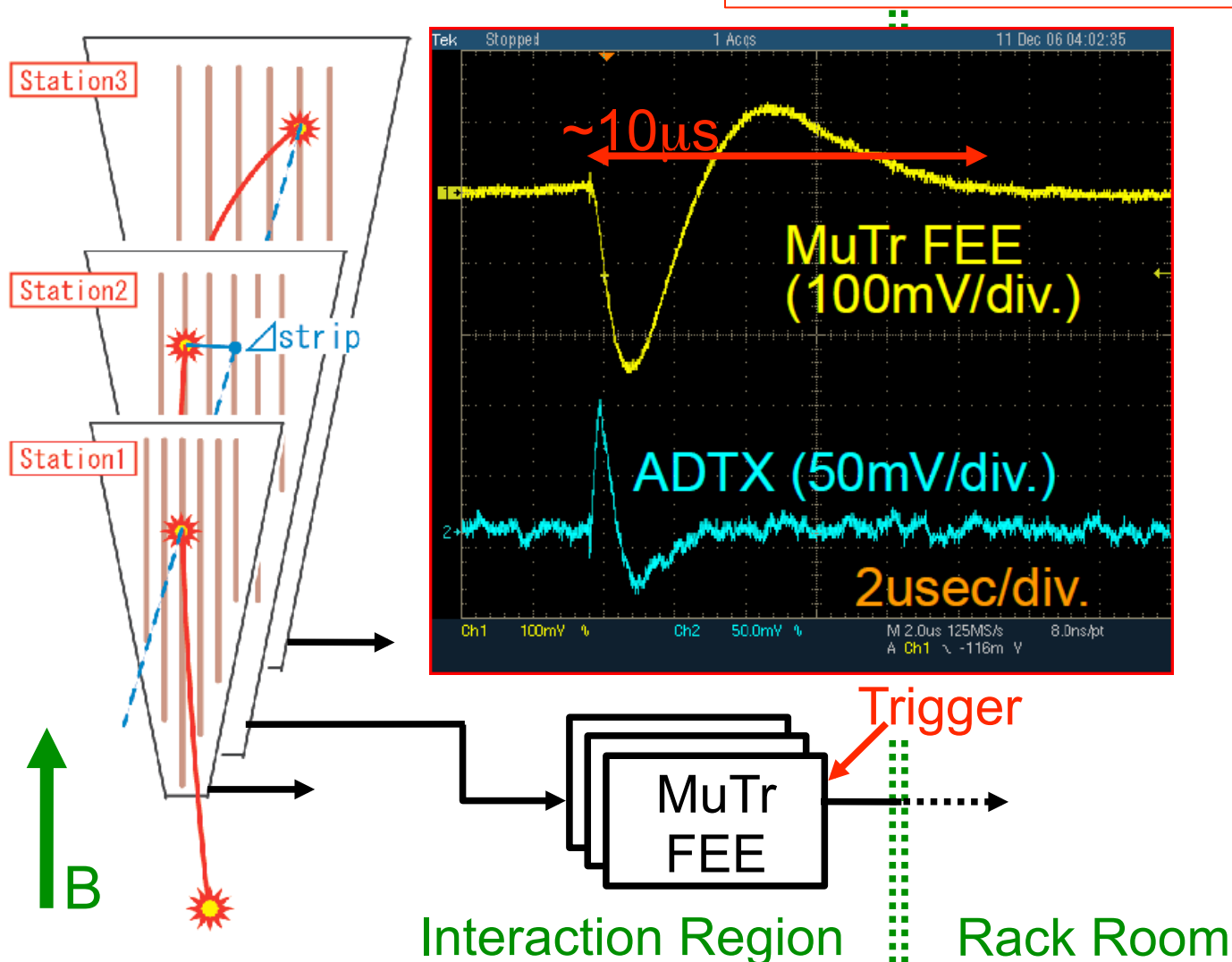
- (II) MuTr front end electronics (**MuTr-FEE Trigger**)

JSPS (Funded)



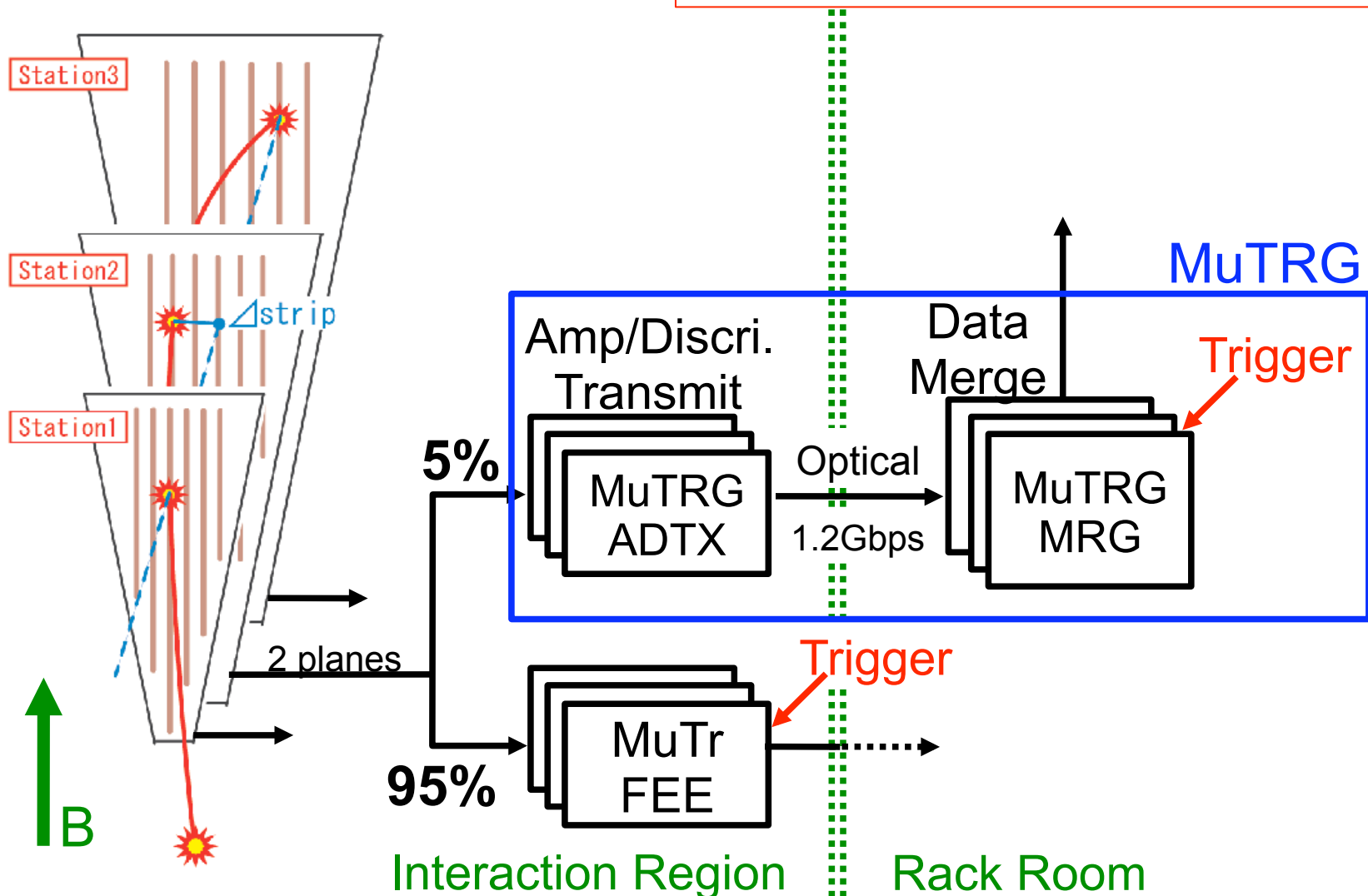
W Trigger System

Trigger events with straight track
(e.g. $\Delta\text{strip} \leq 1$)



W Trigger System

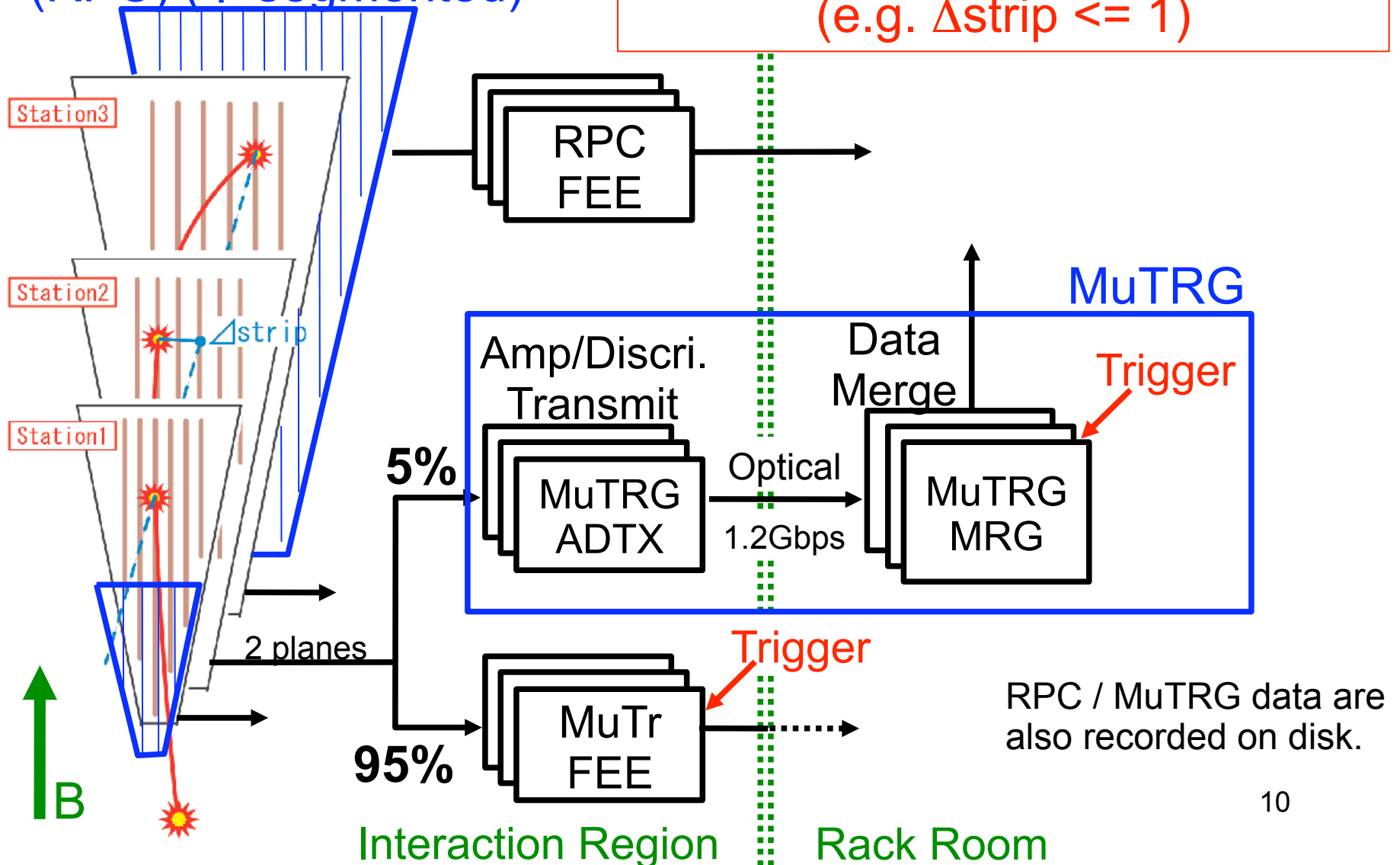
Trigger events with straight track
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W Trigger System

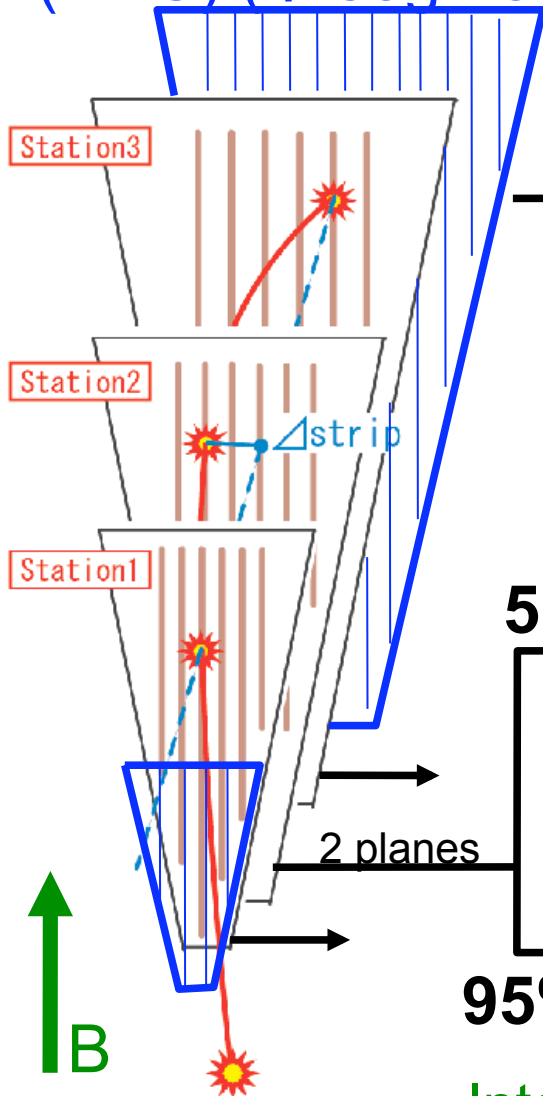
Resistive Plate Counter (RPC) (Φ segmented)

Trigger events with straight track (e.g. $\Delta\text{strip} \leq 1$)

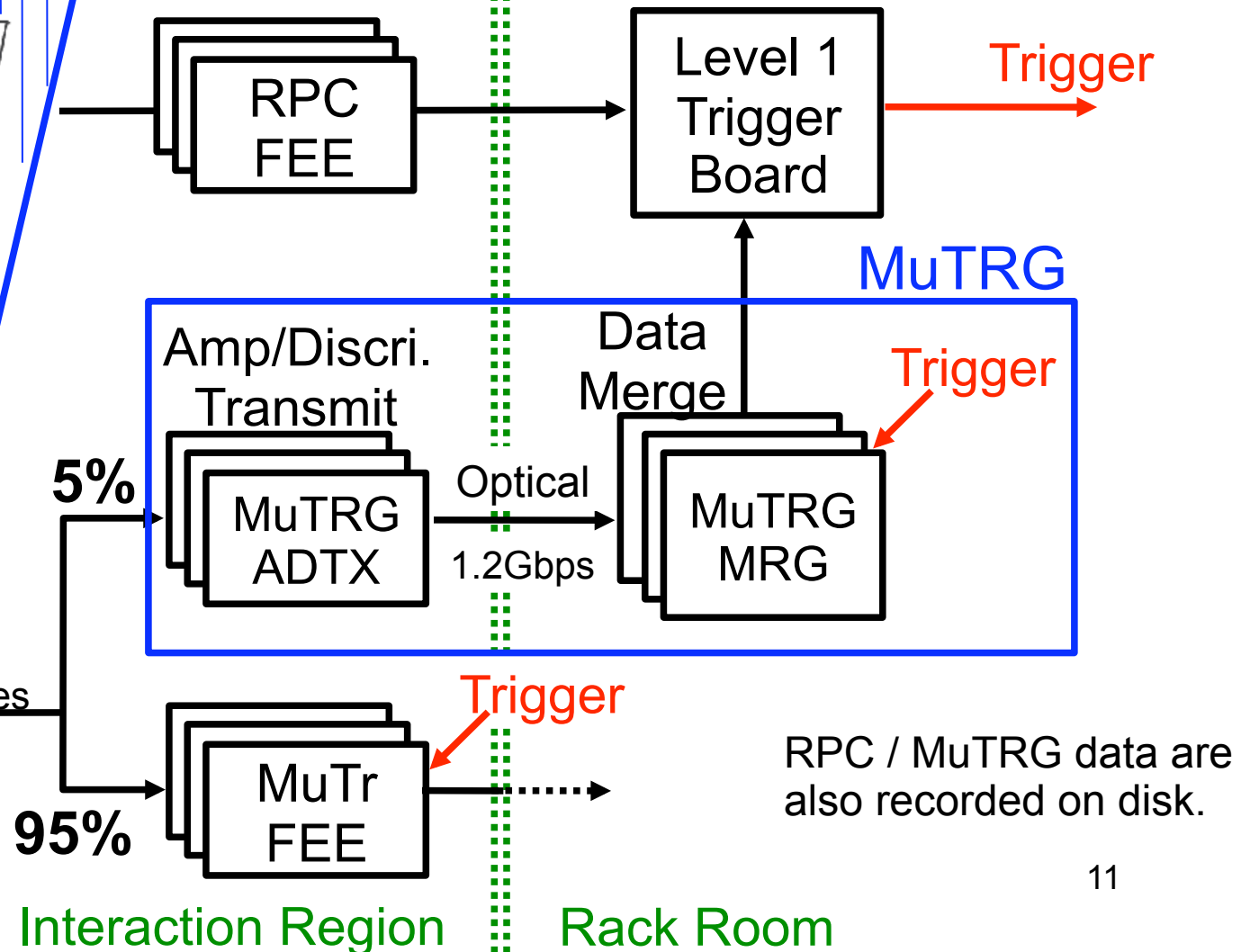


W Trigger System

Resistive Plate Counter
(RPC) (Φ segmented)

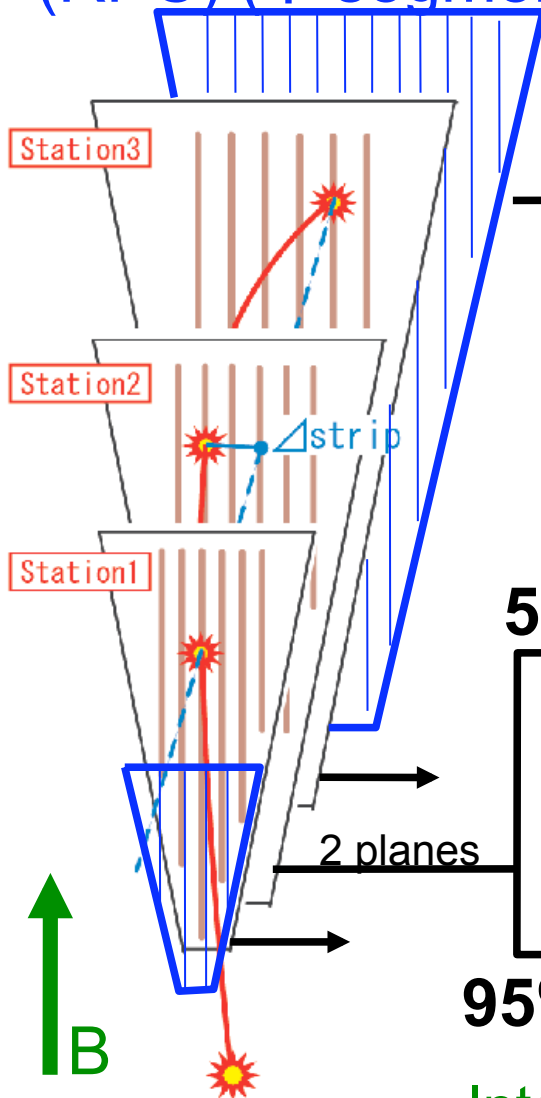


Trigger events with straight track
(e.g. $\Delta\text{strip} \leq 1$)



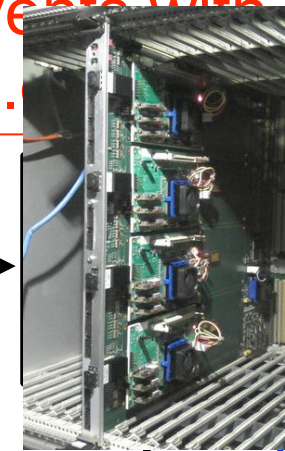
W Trigger System

Resistive Plate Counter
(RPC) (Φ segmented)



Trigger events with straight track
(e.g. $\eta \leq 1$)

RPC
FEE

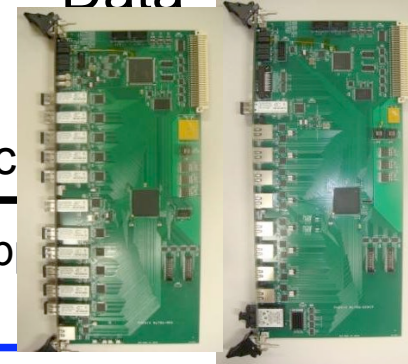
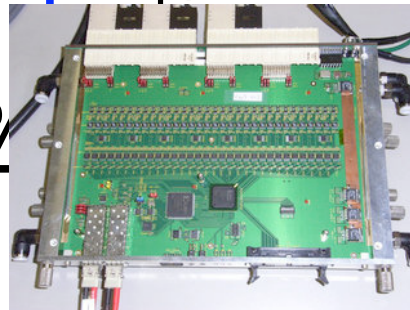


Trigger

MuTRG

Amp/Discri.

Data



trigger

5%

Optic
2Gb

2 planes

95%

MuTr
FEE

Trigger

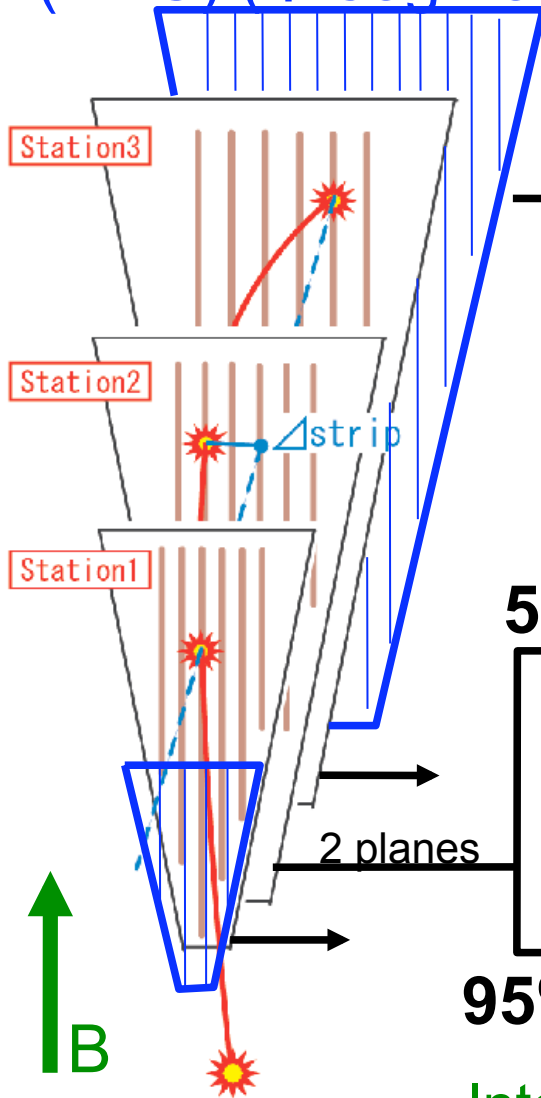
RPC / MuTRG data are
also recorded on disk.

Interaction Region

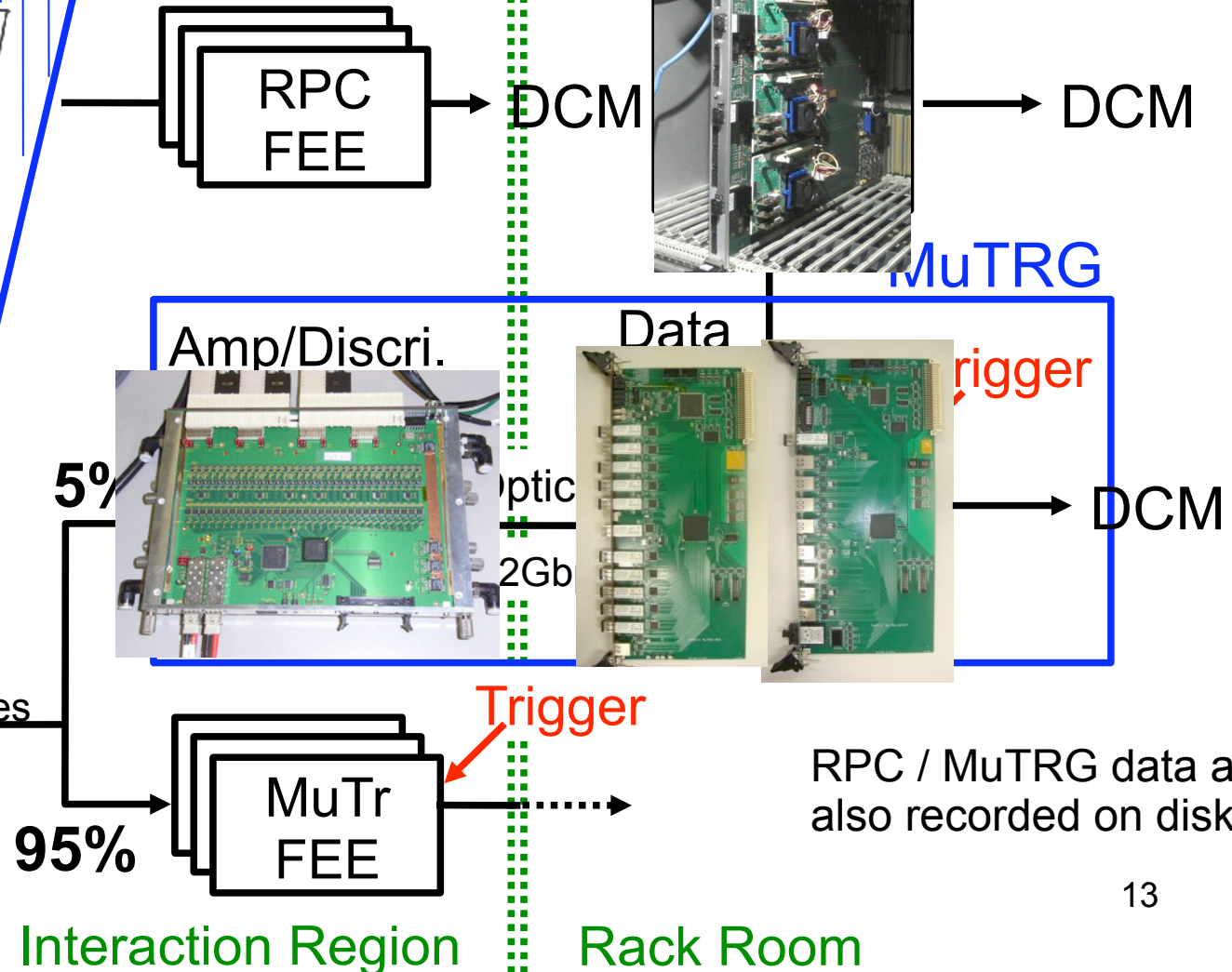
Rack Room

W Trigger System (Final)

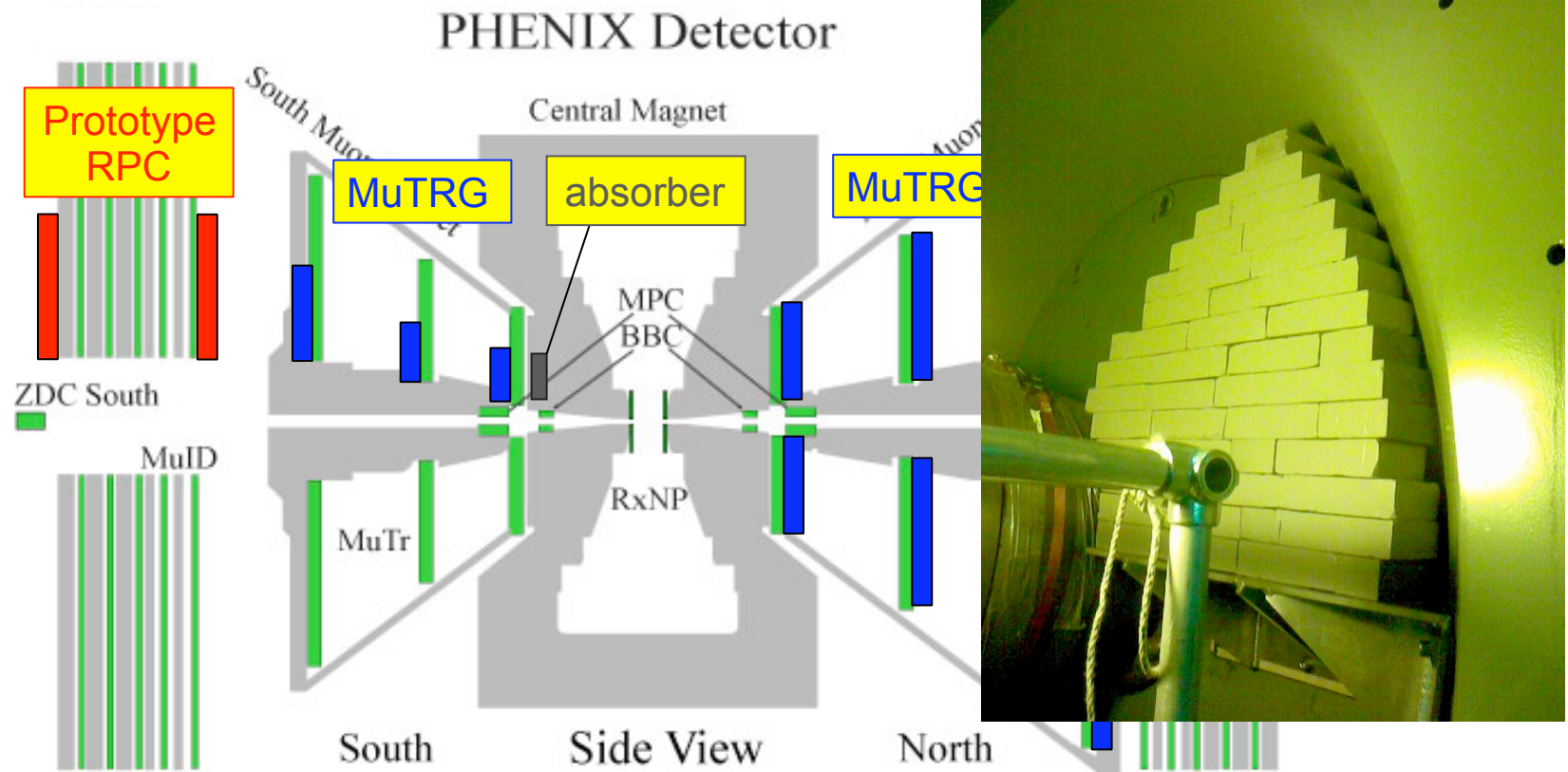
Resistive Plate Counter
(RPC) (Φ segmented)



Trigger events with straight track
(e.g. $\eta \leq 1$)

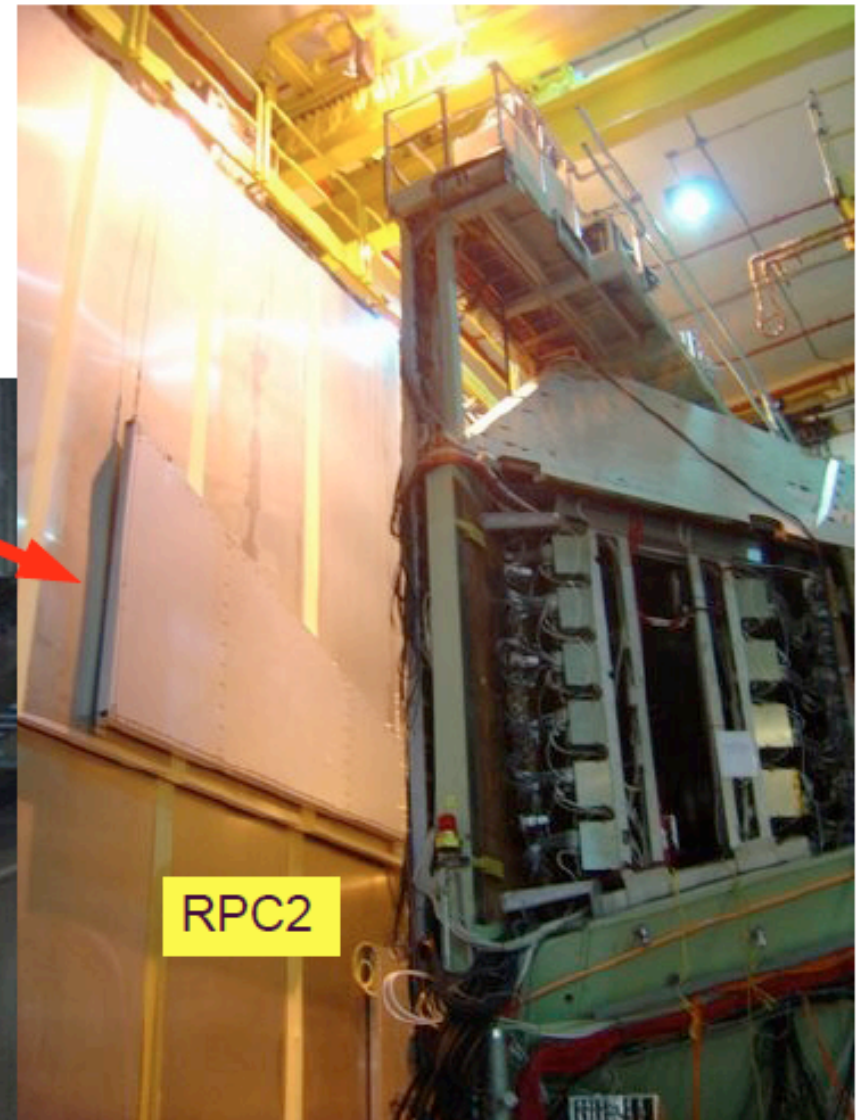
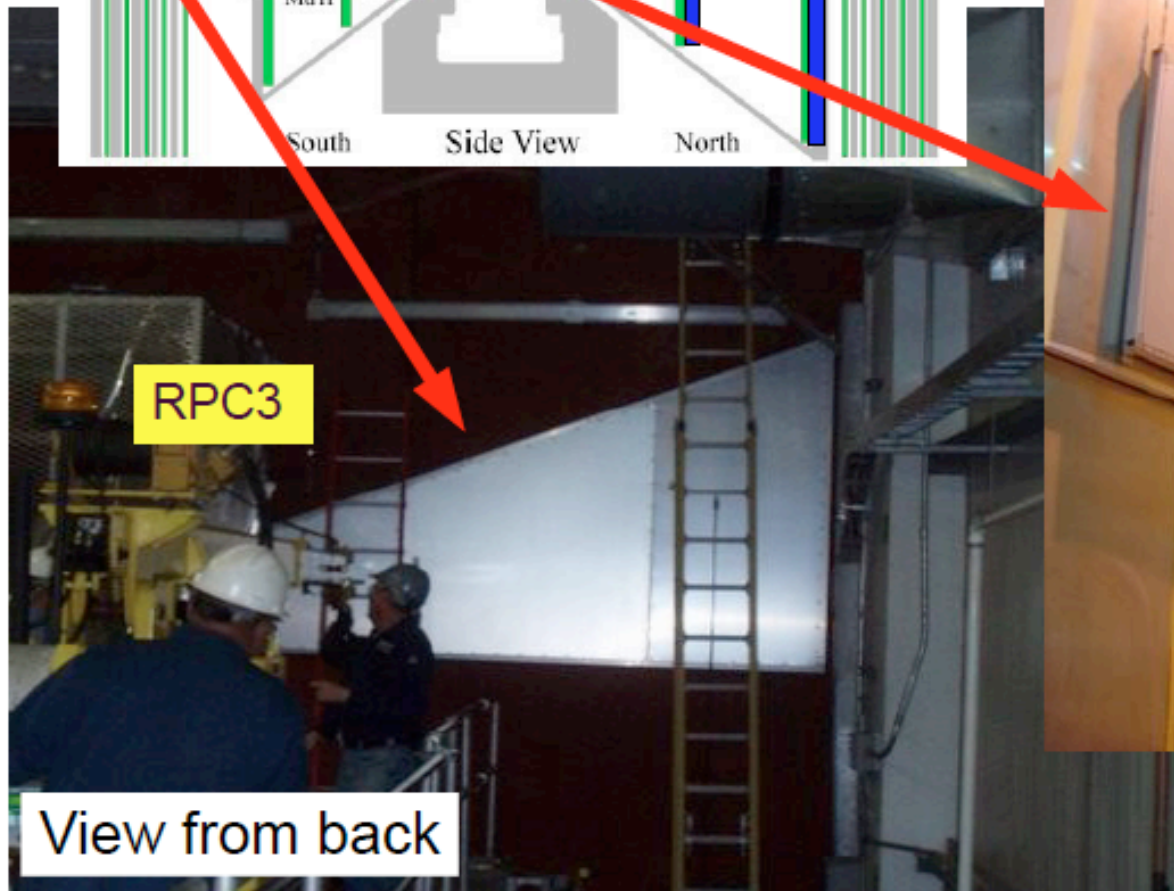
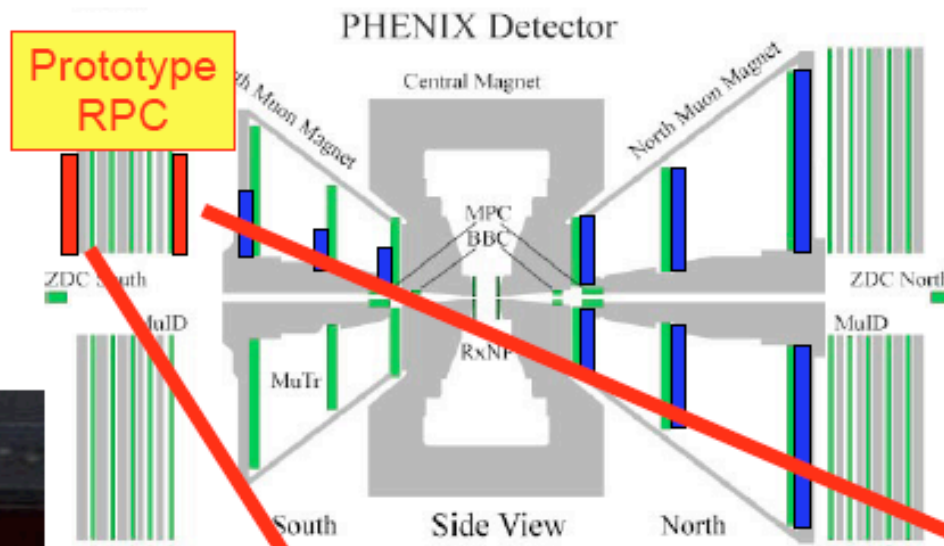


W Trigger Instrumentation in RHIC 2009 run

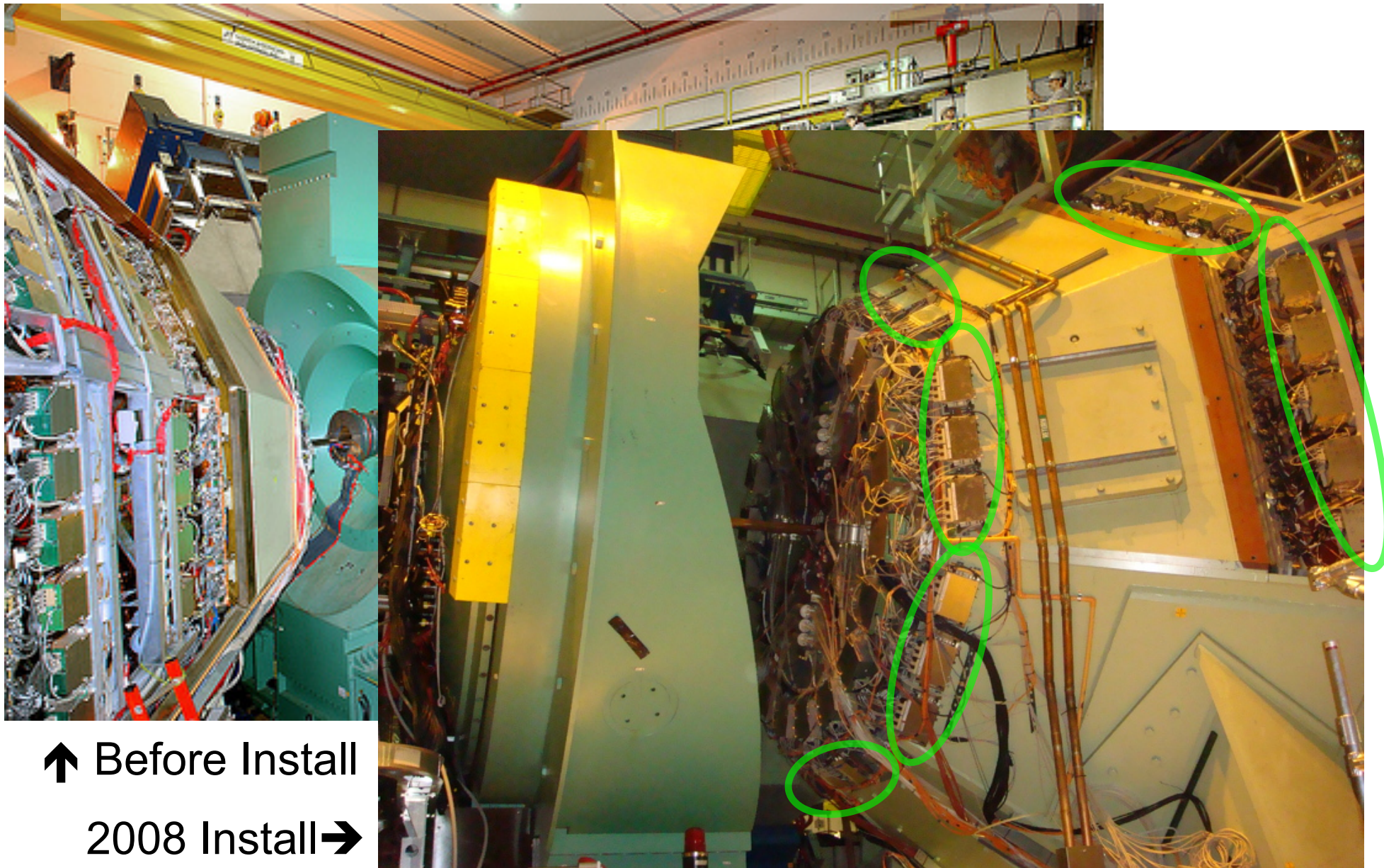


- Full Installation to North Arm, 1/2 octant installed to South
- Demonstrate performance of RPC and MuTRG with beam of $\sqrt{s}=500$ GeV.

Prototype RPC installed in 2009 run



New MuTRIG-FEE in North Arm



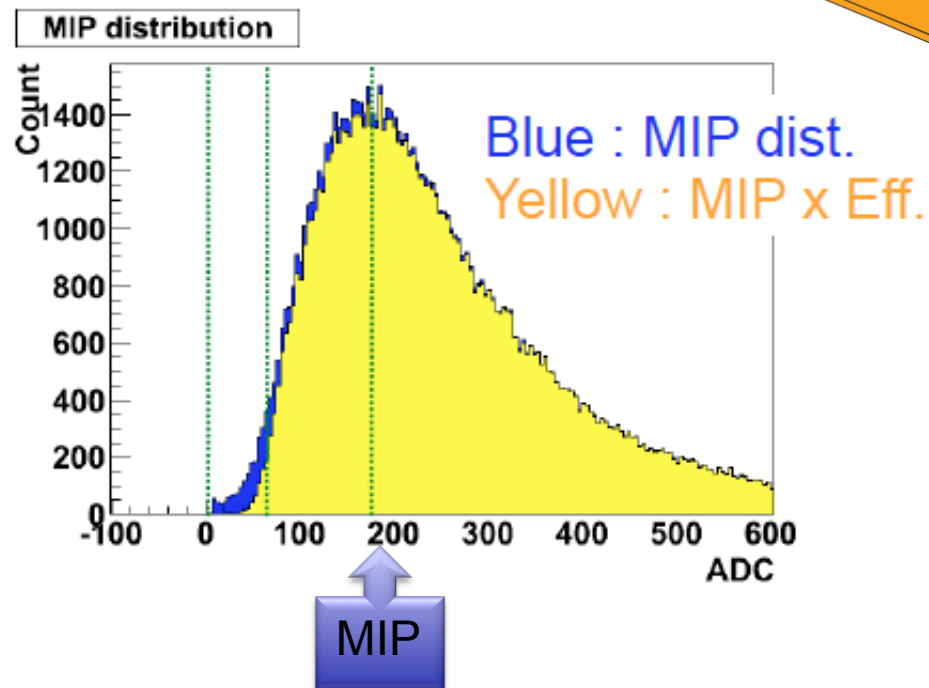
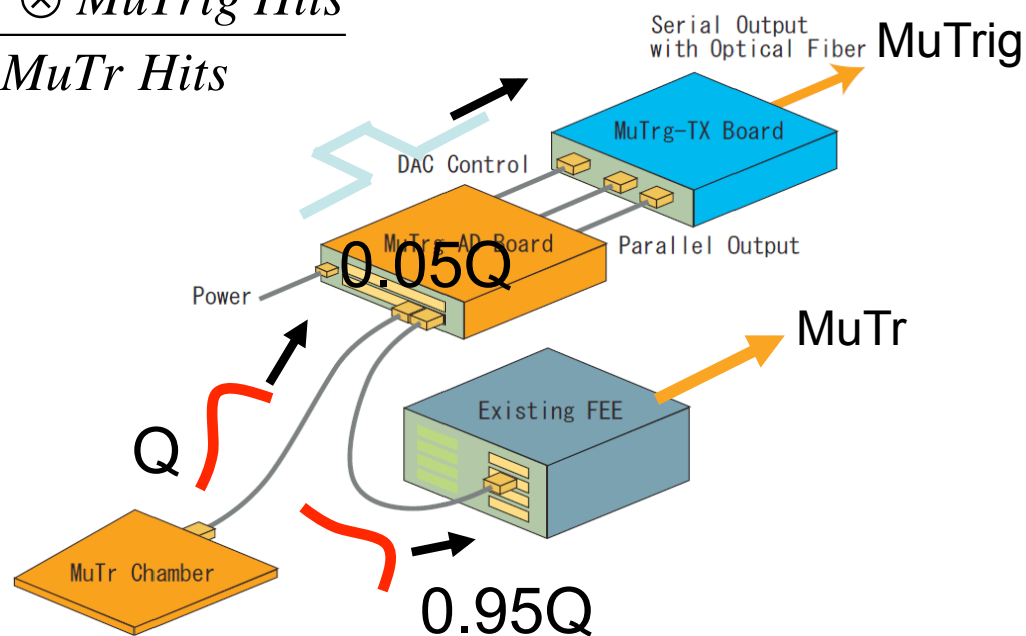
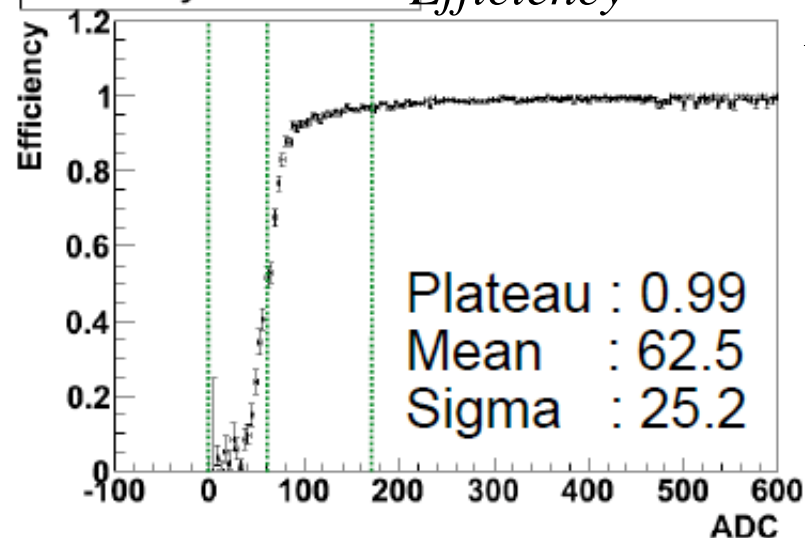
↑ Before Install

2008 Install →

MuTR-FEE Trigger Performance

Single Cathode Plane Efficiency

Efficiency for Station 3 $Efficiency = \frac{MuTr \otimes MuTrig Hits}{MuTr Hits}$

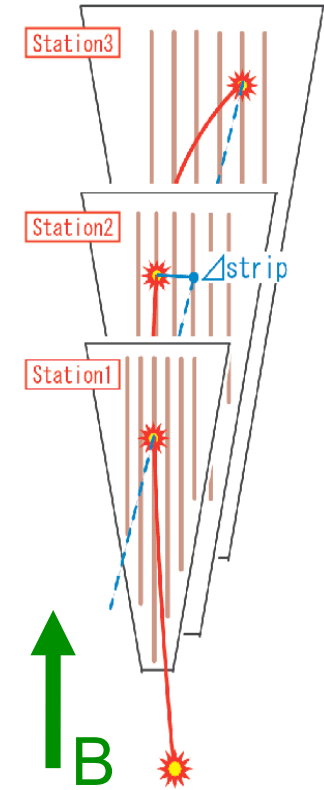
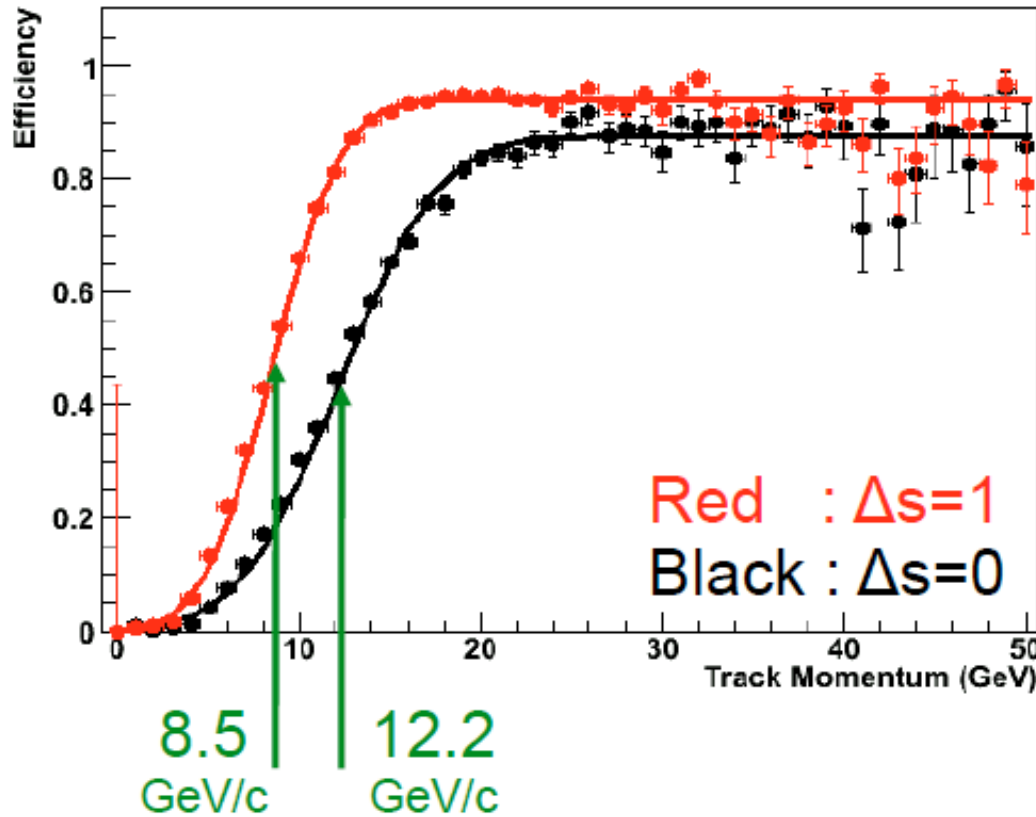


MuTRG and MuTr have matching properly.

Efficiency for MIP is 96% (Yellow / Blue)

MuTRG Efficiency for Track

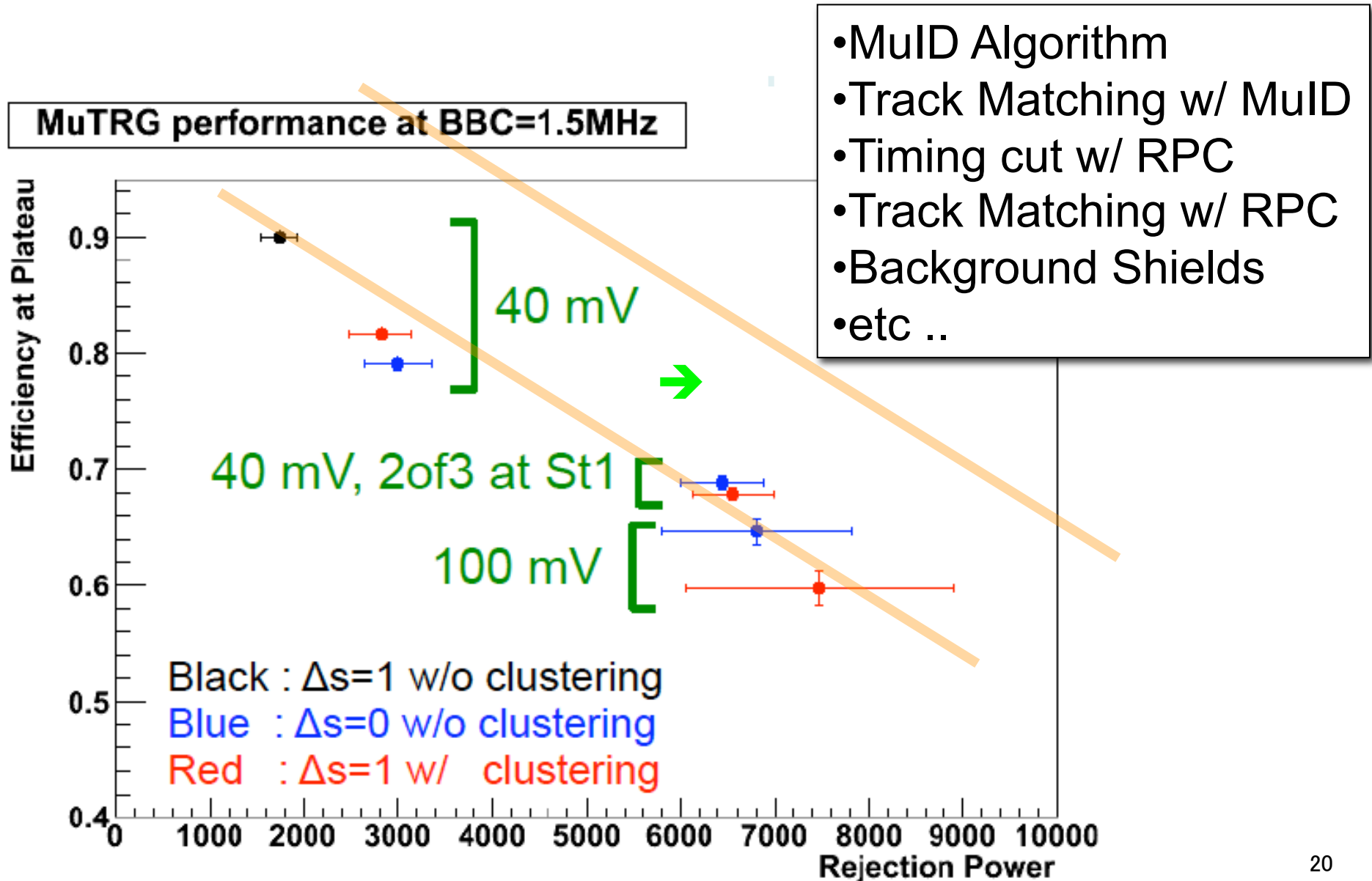
MuTRG Efficiency



Note :
High momentum
track in this plot
must be fake.

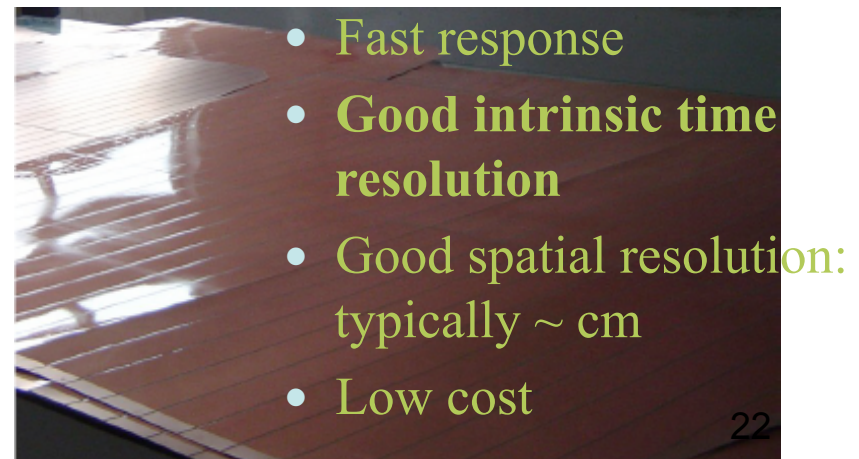
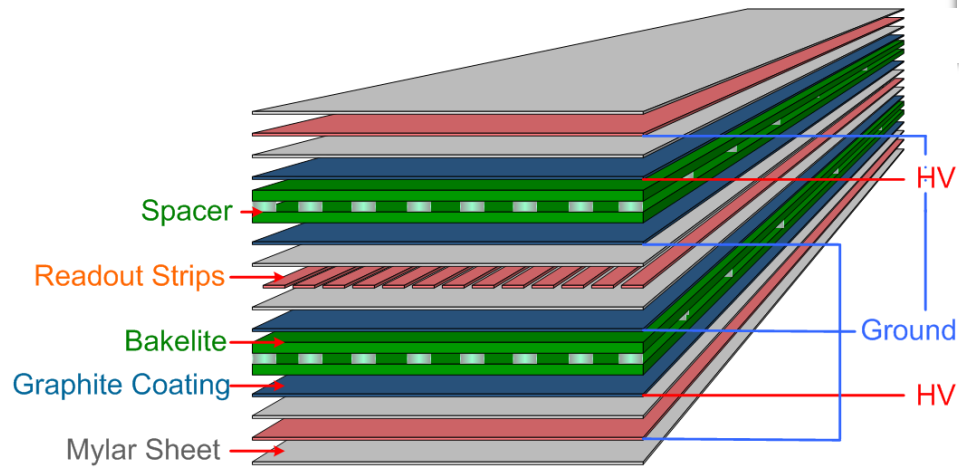
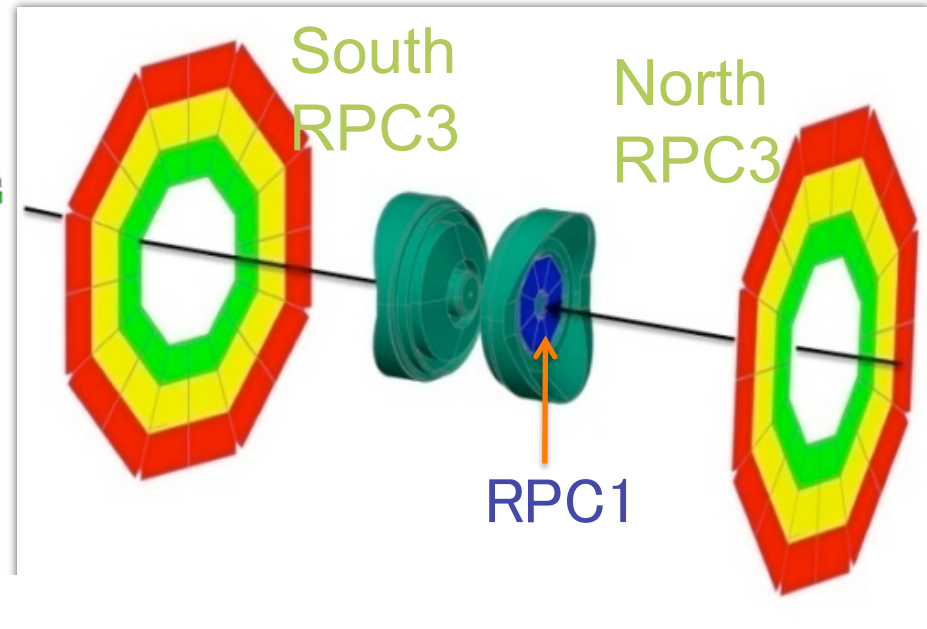
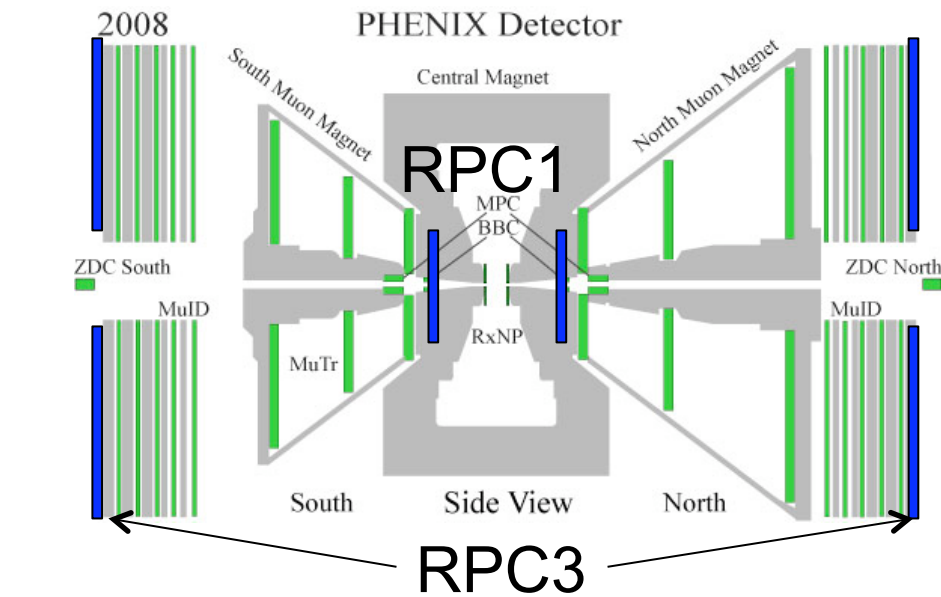
$$\text{Track Efficiency} = (\text{hit efficiency/station} \sim 96\%)^3 \times (\text{vertex cut efficiency})$$

MuTRG System Run09 performance

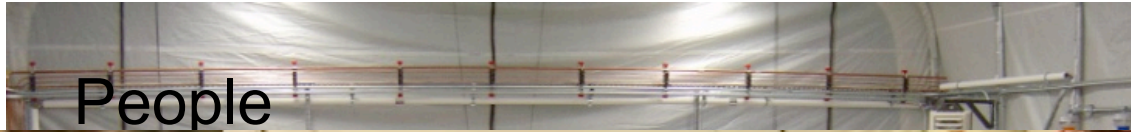


RPC

RPC



RPC Construction



People

Half octant testing

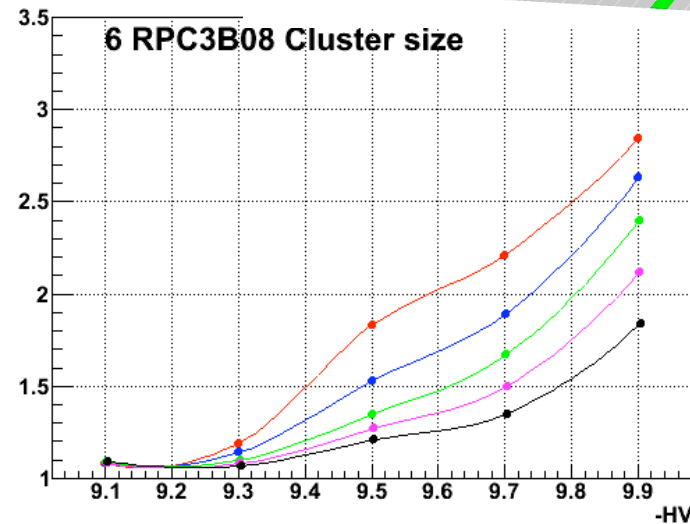
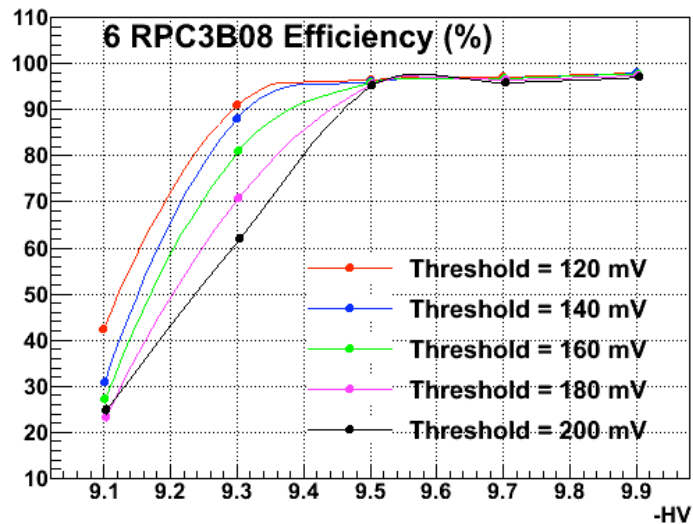
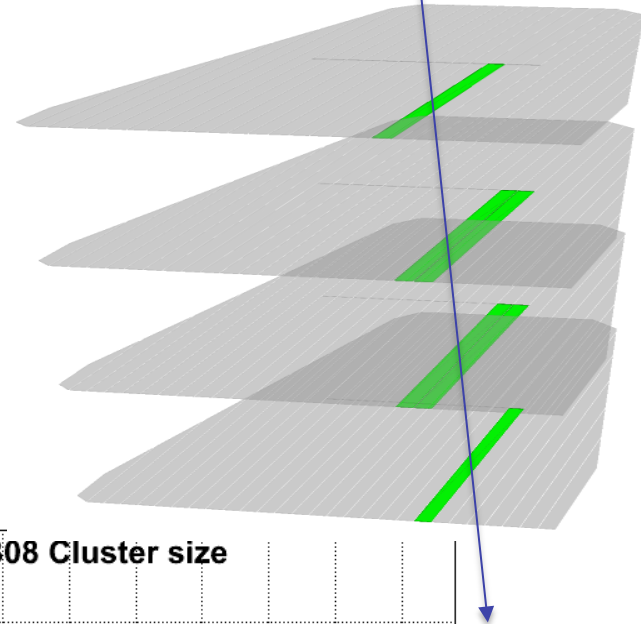


Storage

Pre-Assembly

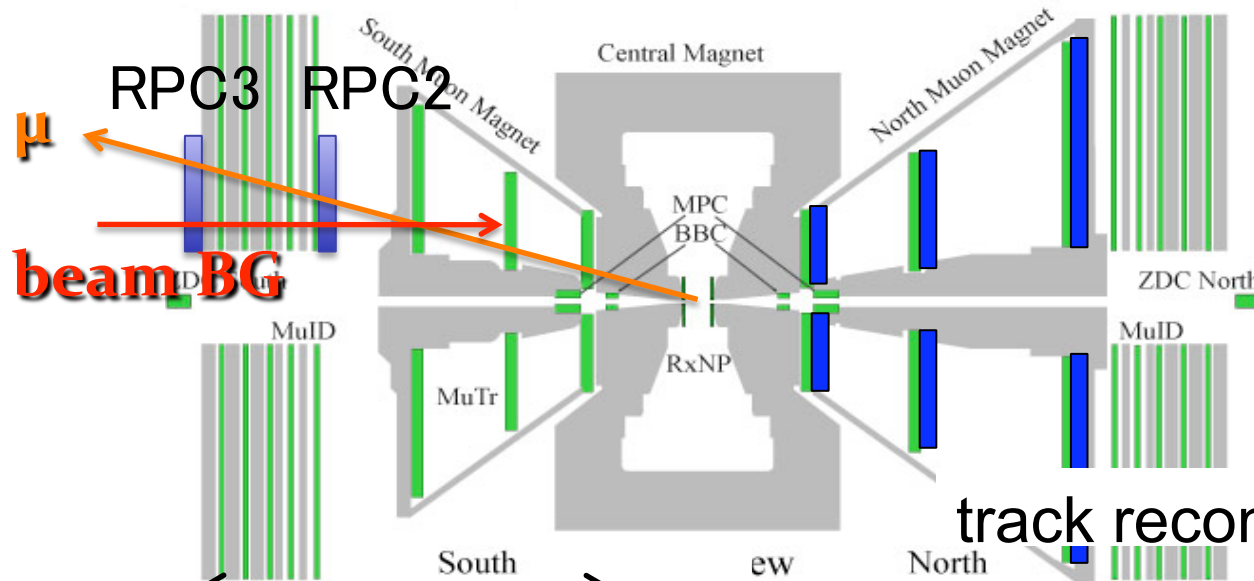


RPC Performance w/ Cosmic



Cosmic Ray test with stack of 5 detector modules

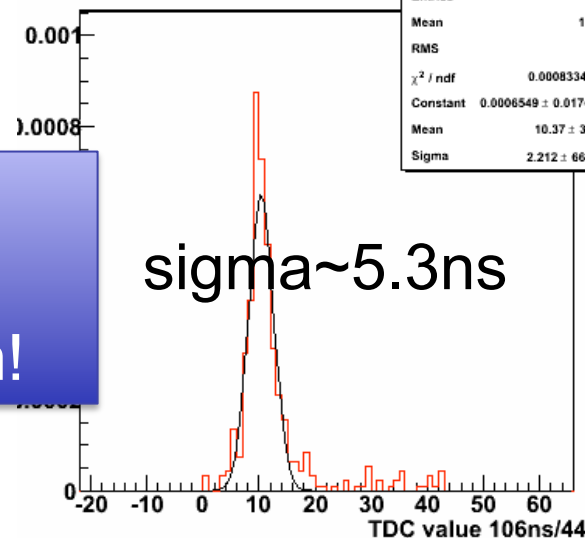
Prototype RPC Performance @ Run9



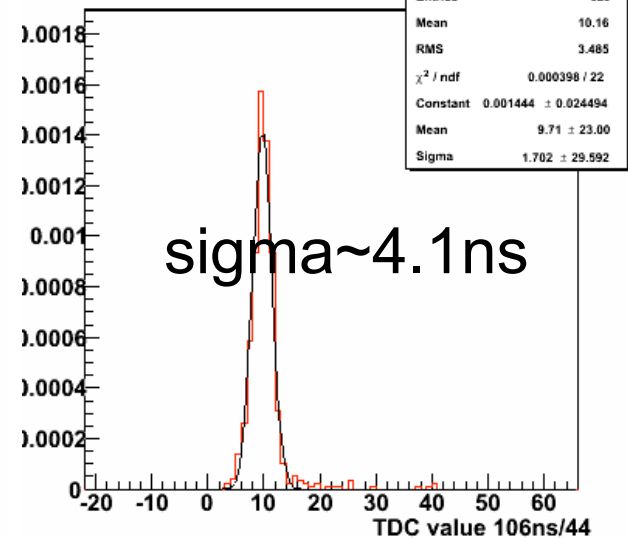
track reconstructed events

Demonstrated
Satisfactory Timing
Resolution w/ beam!

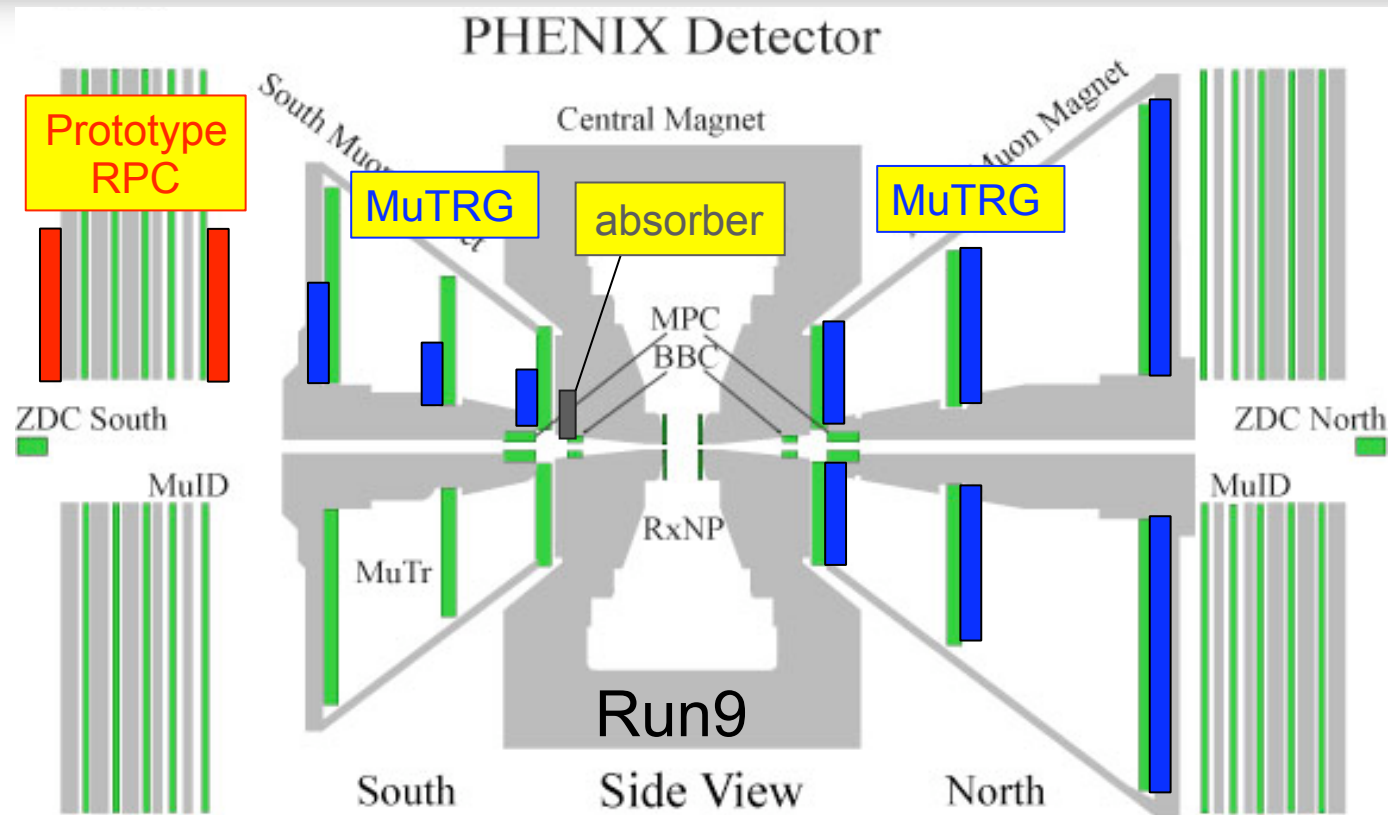
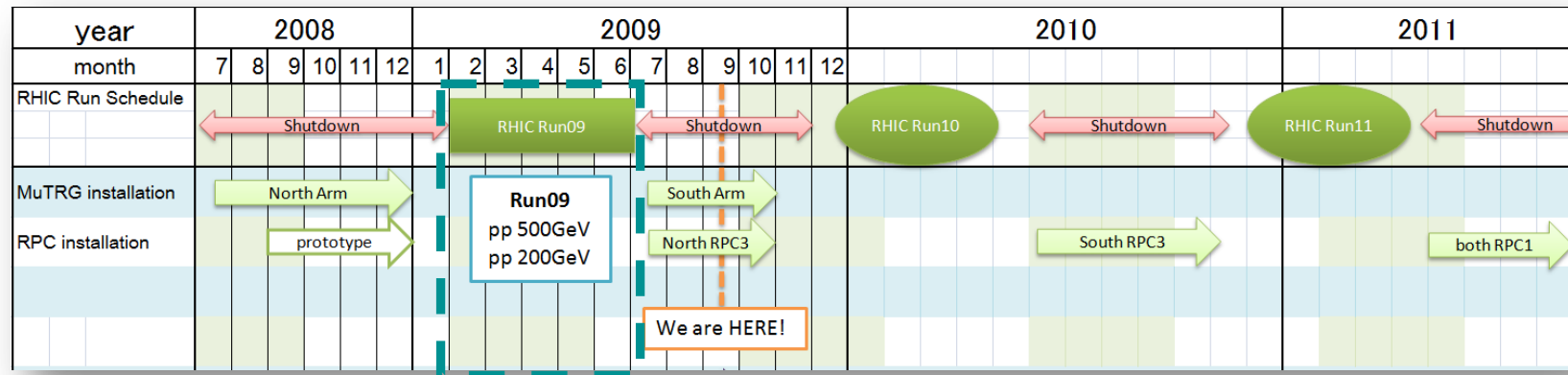
RPC 3, Module A



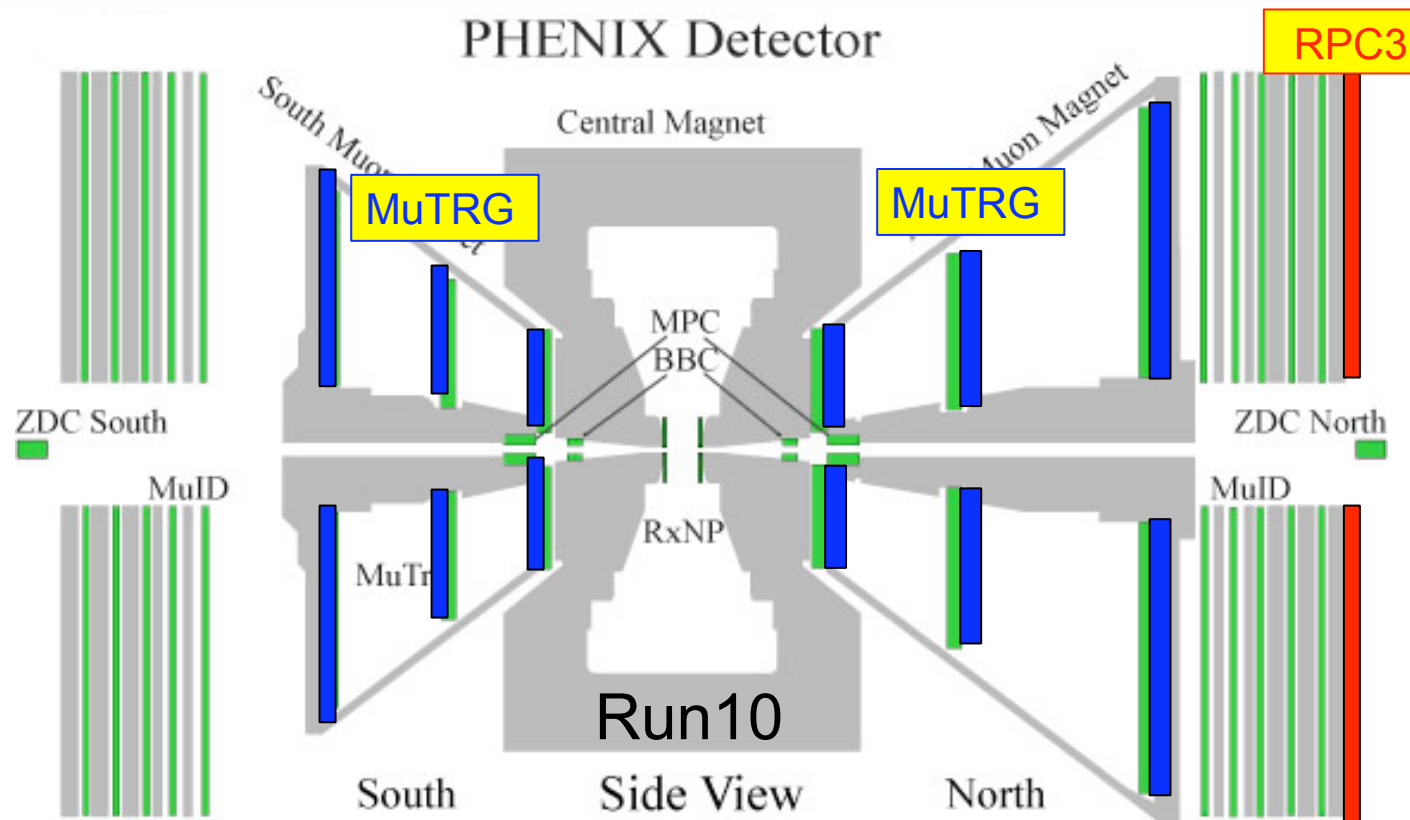
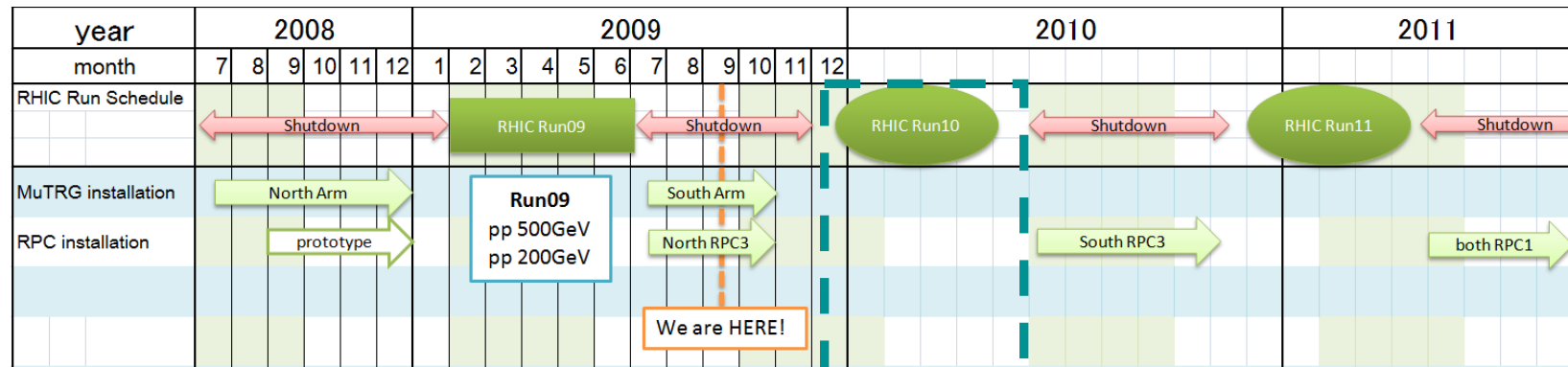
RPC 2, Module A



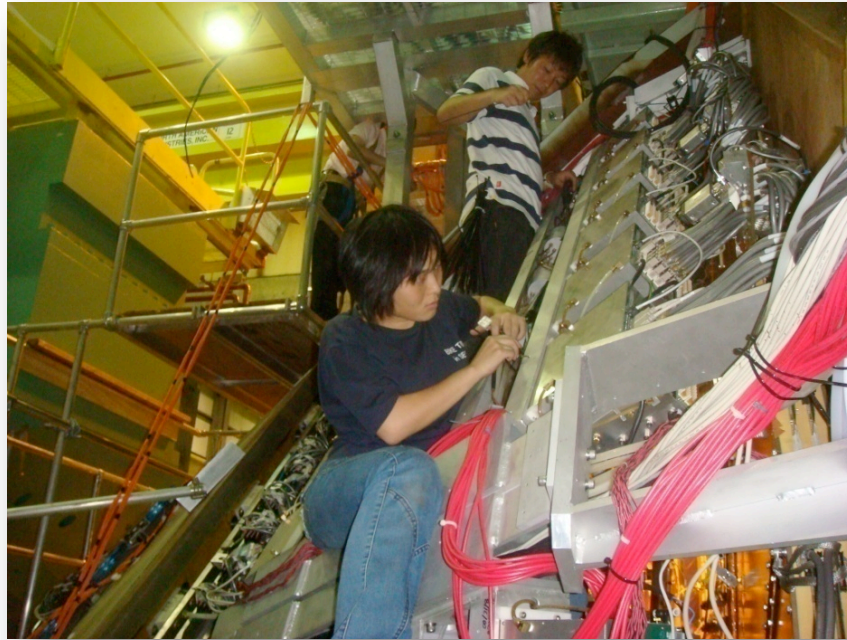
Road Map to Run11 Production Run



Road Map to Run11 Production Run



Installation to South Muon Arm



- Post Run9 Shutdown
- **Completed!**
- Under Commissioning in Run10 Au-Au Run



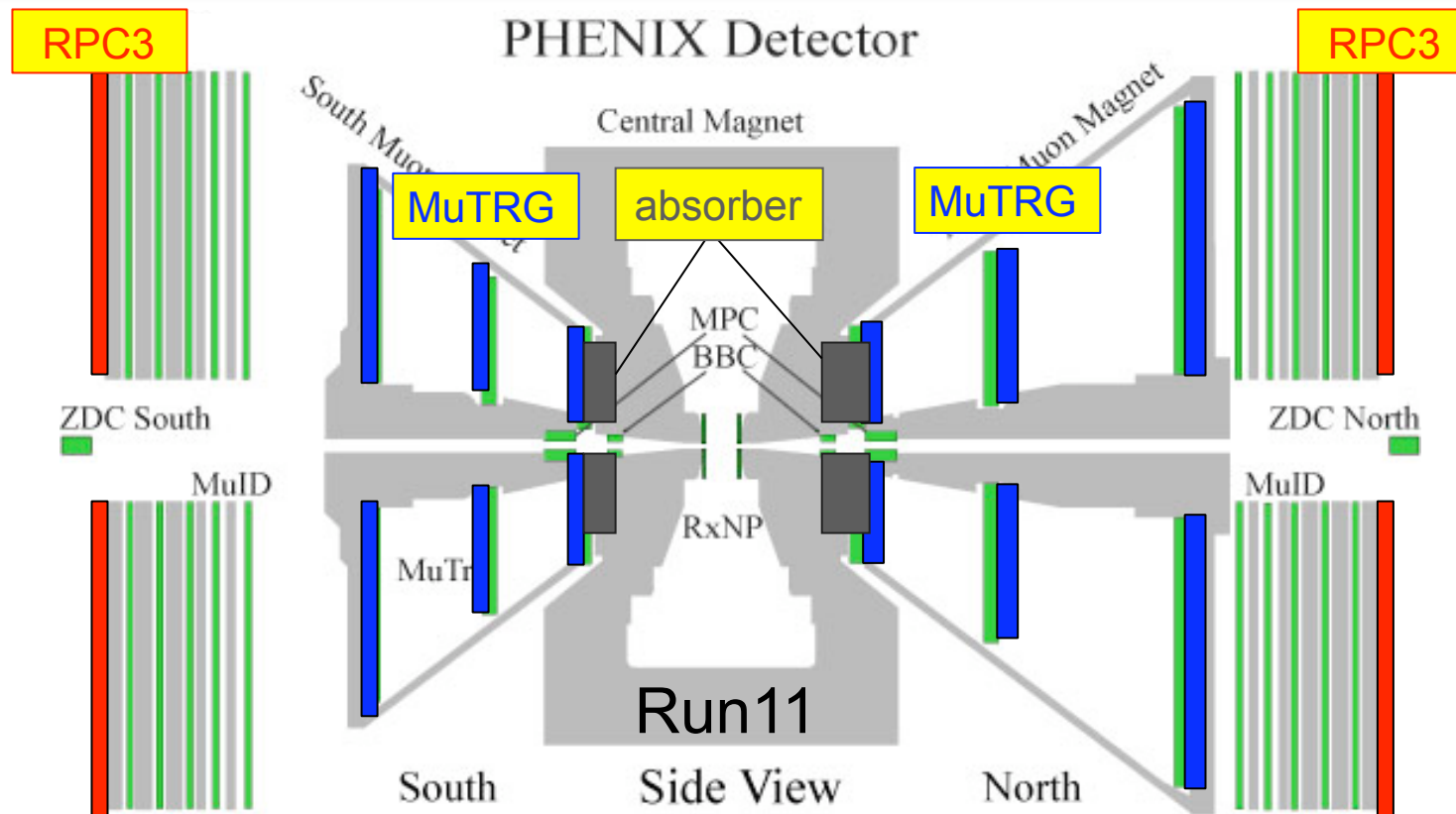
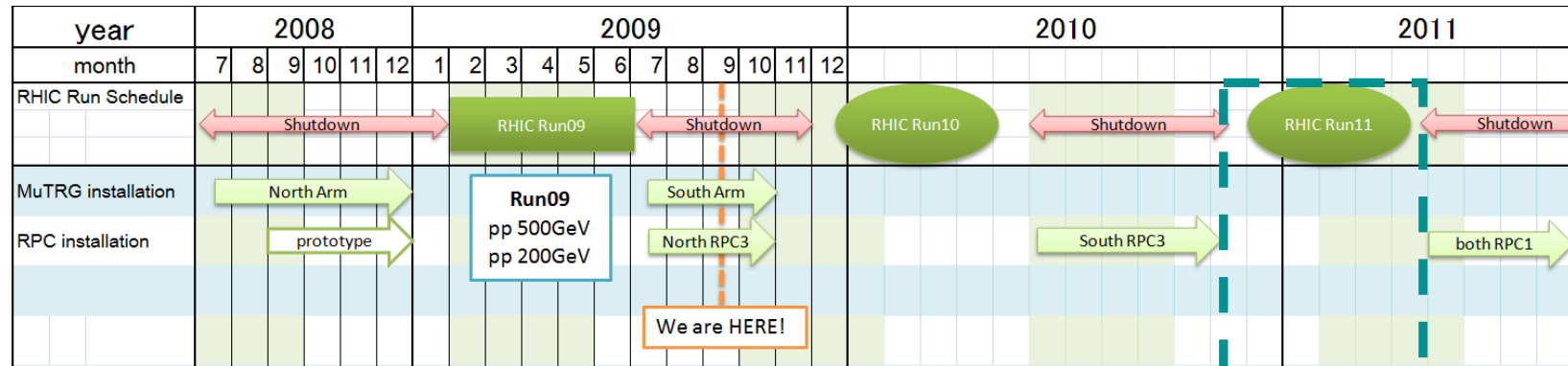
RPC3 North Installation (Nov.'09)



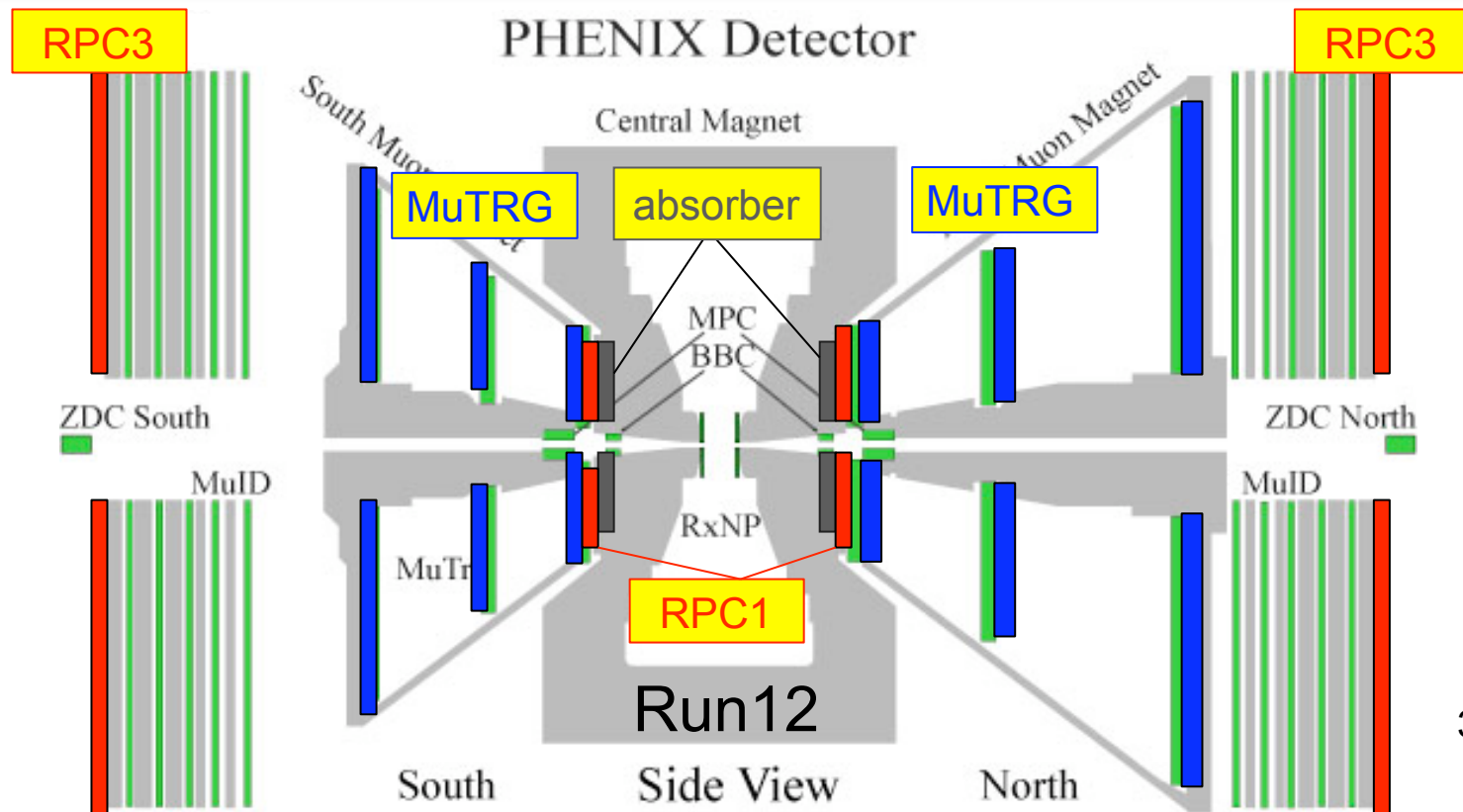
RPC3 North Completed Installation



Road Map to Run11 Production Run



Final Muon Trigger Configuration

[illegible]

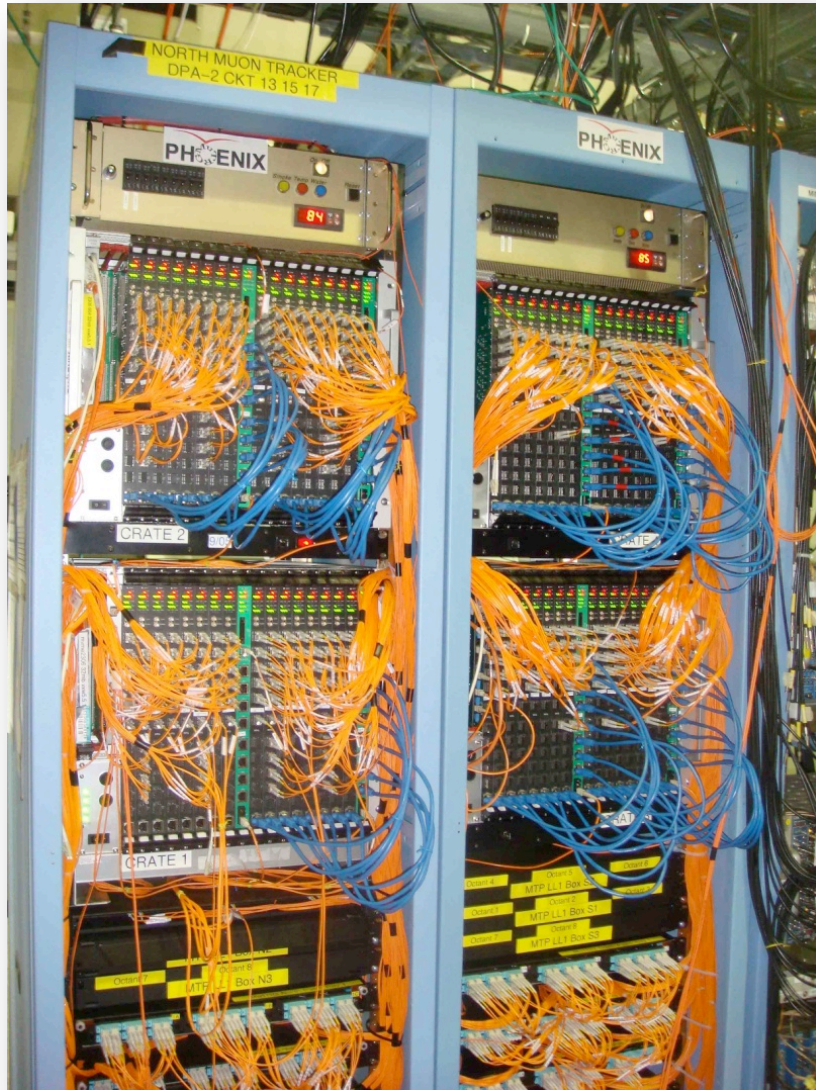
Summary

- Seak Quark Polarization Measurement @ PHENIX via W-Boson
- High Momentum MuTR-FEE Trigger is Completed Installation and to be Commissioned in Run10
- Both MuTr-FEE Trigger and RPC Commissioning Demonstrated Designed Performances.
- More rejection power are expected from
 - RPC (Timing & Matching)
 - MuID Algorithm
 - Background Shields

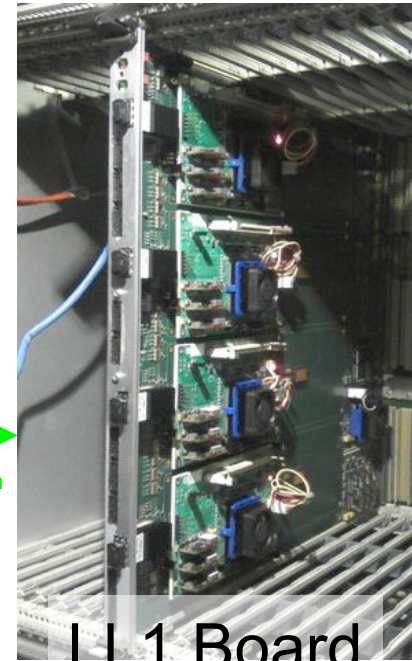
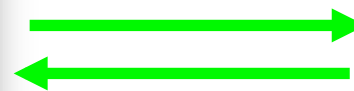
PHENIX Muon Arms are getting ready for pp Production at 500 GeV in Run11

Backup Slides

LL1 Trigger Readiness



MuTRG-MRG Boards



- Communication test ✓
- LL1 Boards Production Completed
- On going ADTX - MRG - LL1 - GL1 chain test now.
- New high momentum trigger will be operated in Run10 for commissioning